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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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ANALYSIS OF THE CLINICAL EFFECTIVENESS OF USING THE CREATED COMBINED FIBRIN-BONE SCAFFOLD FOR THE RECONSTRUCTION OF BONE TISSUE DEFECTS OF THE JAWS

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Abstract.

Aim: The aim of the study was the clinical study of the framework ability of the PRF scaffold obtained by simultaneous centrifugation of the patient's blood and bone-plastic material.

Materials and methods: A total of 60 patients, aged between 20 and 50 years, with radicular cysts of the jaws, were selected for inclusion into the clinical studies. All patients were divided into groups I and II, who underwent cystectomy and bone plastic surgery according to the standard technique using mineralized CenoBone®. However, group II used a scaffold prepared according to the protocol developed by us (patent №136410 and patent №156181) using a titanium Ti-6Al-4V filter developed by us (patent № 152966).

Results: The results of the aforementioned postoperative radiological examinations confirm the efficacy of the filter, and the technique devised by our research team, which enables the creation of a stable fibrin matrix with embedded granules of bone-plastic material. The efficacy of the treatment was evidenced by the simultaneous uniform regeneration of bone tissue across the entire thickness of the defect in group II, with a success rate of 86.66%. This is evidenced by the organized architecture of bone tissue with a pronounced trabecular pattern, which correlated with bone density indices from 715.18+14.33 to 652.42+27.34 HU. In this group of patients, these values corresponded to the intact bone. In contrast, in 22 (77.08%) patients of group I, the predominant bone structure was compact, with values ranging from 965.47+21.25 to 876.26+24.67 HU. This observation is believed to be attributed to the presence of unresorbed material granules, which form a compact framework for bone germination. Nevertheless, among the 22 patients in group I, only 13 (59.09%) exhibited complete restoration of the defect, while the remaining 9 (40.91%) displayed indications of merely peripheral bone restoration, characterized by a pronounced granular pattern in the centre.

Conclusions: The stable combined fibrin scaffold obtained by us, has a pronounced osteoconductive and osteoinductive effect, which is reflected in the complete restoration of bone tissue throughout the thickness of the defect.

Key words. Bone tissue, combined fibrin scaffold, titanium filter, radicular cyst, bone-plastic material.

Introduction.

One of the relevant aspects of modern medicine is the timely detection, prevention and rehabilitation of patients with chronic inflammatory processes of the facial skeleton bones. Among chronic inflammatory processes, chronic forms of osteomyelitis and radicular cysts are the most frequent and problematic in the rehabilitation program, since these pathologies most often lead to the destruction of bone tissue and require the use of reconstructive plastic surgery [1-3].

Surgical stomatological interventions in chronic inflammatory processes leading to destructive changes in the facial skeleton often involve the use of implant materials based on tricalcium phosphate and hydroxyapatite for additional structural support during the restoration of bone tissue [4-6]. However, when using the specified materials and standard methods, there is a problem of restoring the full structure of the bone tissue, which is associated with the untimely degradation of the granulate and the development of bone tissue hyperostosis or the formation of connective tissue around the implanted granules. A number of studies have identified the importance of a matrix based on biocompatible biodegradable materials in the reconstruction of tissues and the structure of a functional carrier for these tissues or cells [7,8].

The analysis of literature data indicates a comprehensively growing interest in autologous materials, which are currently regarded as the "gold standard" in reconstructive technologies. This is related to such criteria as histocompatibility, lack of toxicity and the presence of certain factors that, directly or indirectly, affect wound healing processes. Among the most promising biomaterials are those belonging to the platelet-rich fibrin (PRF) category. These materials offer a number of advantages, including an increased release of proteins and growth factors, the proliferation of fibroblasts, and the ability of these cells to migrate and express growth factors. [9-13]. The use of these materials was conducted in both the context of both post-extraction defect-filling procedures following the removal of third molars [14] and during other surgical interventions [15-17]. This type of plasma was used in both a gel-like form and an injectable one [17-19].

In addition to practical clinical application, laboratory studies of the properties of the specified autologous material continue to date. Thus, in particular, the authors Crisci A, Barillaro MC found that L-PRF (rich in fibrin in platelets and leukocytes) and its derivatives (A-PRF, i-PRF) are useful as a basis for stem cells in wound regeneration [20,21]. Thus, in particular, the use of PRF technology in combination with bone-plastic material creates optimal conditions for the regeneration of bone tissue. For example, the results of studies by Kim BJ, Kwon TK are interesting, as well as by other authors who evaluated a matrix rich in platelets and fibrin (PRF) mixed with tricalcium phosphate and recombinant human bone morphogenic protein 2 (rhBMP-2) and its potential to enhance bone regeneration in sinus lift [22]. However, the analysis of the extant methodologies showed that when using PRF technology in combination with bone-plastic material, the so-called injectable PRF is usually used, as this particular consistency represents the sole viable means of achieving full integration of the bone granulate and growth factor-enriched plasma.

The disadvantage of this technique is the lack of mechanical stability of such a hybrid, combined scaffold. In contrast, the alternative technique results in the formation of a mechanically stable gel-like framework within the test tube during centrifugation. Thus, the authors of De Almeida Nóbrega Correia Pascoal, M performed a comparative analysis of the tensile strength of platelet concentrates between two different autologous platelet concentrates (fibrin enriched with leukocytes and platelets versus fibrin enriched with platelets) [23,24]. However, it is not possible to fully mix this type of gel-like PRF with bone tissue.

It is our considered opinion that the combination of a mechanically stable fibrin PRF matrix with an integrated bone-plastic material will ensure the stability of the scaffold in a bone defect. Furthermore, the incorporation of growth factors will facilitate the stimulation of bone tissue regeneration.

The aim of the study was the clinical study of the framework ability of the PRF scaffold obtained by simultaneous centrifugation of the patient's blood and bone-plastic material.

Materials and Methods.

Titanium filter design. To obtain a scaffold received by simultaneous centrifugation of the patient's blood and bone-plastic material, we have developed a suitable titanium filter (Patent №152966. A61L 33/00. Published on May 03, 2023, Bull. №18/2023).

The filter is made of light biocompatible titanium alloy Ti-6Al-4V. To guarantee the simultaneous filtration of blood during centrifugation and the stable location of granules of bone-plastic material, the structure developed by us is constructed in the form of an open frame with a filtering component. The specified segment contains evenly spaced concentric semicircular slits (slots) with a lumen width that does not exceed the diameter of the granules of bone-plastic material and is not smaller than the size of blood cells. The geometry and dimensions of the apertures in the filtering component of the titanium filter are primarily a consequence of the objective to achieve the maximum feasible expansion in the filtration area. The aforementioned calculation was based on two key factors: firstly, the maximum possible volume of bone-plastic material that can be retained during centrifugation on the filter part of the device; and secondly, the diameter of the bone-plastic material granules, which was determined based on the distance between the granules themselves (Figure 1).

Since the specified device will be situated within a test tube throughout the course of the centrifugation process, its design was created based on the calculation of the optimal mass (up to 4 g), balance and stabilization of its position under the action of rotation and centrifugal force. Thus, stabilization and balance with uniform mass distribution are provided by one supporting and two frame legs, an upper locking ring and a filtering part with a cylindrical stabilizer.

Clinical studies. A total of 60 patients, aged between 20 and 50 years, with radicular cysts of the jaws, were selected for inclusion into the clinical studies. In order to ensure the reliability of the analysis of the dynamics of defect recovery, the size of the defect, which did not exceed 25 mm, was also taken into account when selecting patients. All examined

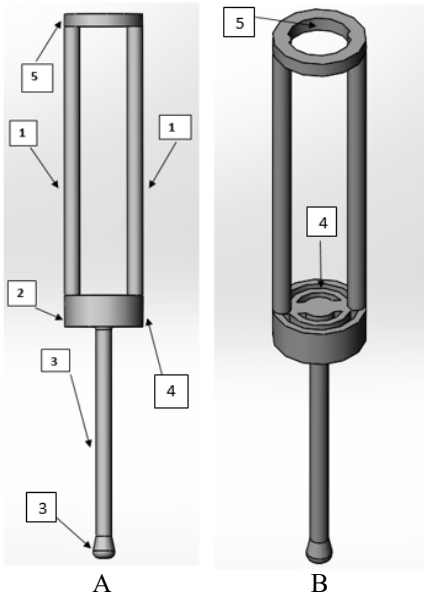

Figure 1. *The 3D sketch depicts a filter for the simultaneous centrifugation of the patient's blood and bone-plastic material. A – side view: 1-component part of the frame (two frame legs), 2-cylindrical stabilizer of the device, 3-support leg. B – view in axonometry: 4-filter part of the device with semicircular slots, 5-upper locking ring.*

patients were found to be practically healthy, without any accompanying somatic pathology, and without any of the following factors: orthopaedic structures in the areas of surgical correction, a pathological condition of the oral cavity, tobacco abuse, unsatisfactory oral hygiene, or any other factor that could directly or indirectly affect the results of the studies.

In order to determine the effectiveness of the combined matrices obtained by us, all patients were divided into two groups, taking into account the use of one or another technique. The group I included (n=30) patients who underwent cystectomy in combination with bone plastic according to a standard technique using only mineralized bone plastic material in the form of granules CenoBone® (manufactured by Cenobiologics Ltd) and isolating collagenous membrane Collprotect® membrane. Group II comprised (n=30) patients who underwent cystectomy in combination with bone plastic surgery in accordance with a recognized surgical technique. However, the scaffold was prepared according to the protocol developed by us (patent №136410. A61C 8/00, A61C 9/00. Published on August 08, 2019, bulletin №2/2018 and patent №156181. A61K 35/14, A61L 33/00. Published on May 22, 2024, bulletin № 21) using the filter developed by us.

First, venous blood was taken from the patient into a tube with a plasma activator. For this technique, well-known vacuum tubes were chosen, for example, BD Vacutainer® with a coagulation activator – with silicon oxide SiO sprayed on the inner walls. Next, a device developed by us was placed into the test tube. Then, granules of mineralized bone-plastic material CenoBone® produced by the Ceno Biologics company, were poured into the test tube.

After that, the test tube was tightly closed and placed into a CROSS-D PREMIUM centrifuge, and centrifugation was carried out first for 12 minutes at a speed of 2500 rpm, then

for 3 minutes at a speed of 3000 rpm. After centrifugation, the erythrocyte mass remained in the lower third of the test tube, passing through the pores between the granules of bone-plastic material and through the filtering part of the device. However, granules of bone-plastic material remained on the surface of the filtering part of the device. In the upper half of the tube, an organized fibrin framework was formed with platelets and growth factors integrated into a porous framework of osteoplastic material. After centrifugation, the combined scaffold was removed from the test tube and inserted into the area of the bone defect, covering it with an insulating collagen membrane Collprotect® membrane (Figure 2).

A B

Figure 2. *The main stages of preparation after centrifugation: A – placing the material in the test tube after centrifugation, B – preparing the material for introduction into the defect zone.*

The efficacy of the technique developed by us, was evaluated using clinical and radiological indices. Early clinical results in patients of the I and II groups in the postoperative period were evaluated by such clinical signs as the presence or absence of pain, swelling, the state and degree of separation of the wound edges, the release of exudate from the dentogingival pockets and along the incision line. X-ray analysis was performed prior to surgery and at 6 and 12 months following surgical treatment. Computed tomography (TOSHIBA Aquilion PRIME 160-slices MODEL TSX-302A/1C equipment) was used to assess bone tissue density and structure. Analysis of bone tissue density according to Hounsfield GN (1919) HU and its structure was performed in the SimPlant Pro 11.04 software. To compare bone tissue density indicators, we used both intact areas of the jaws and additionally archival data of computer tomography of 30 patients of the control group without bone tissue pathology of the maxillofacial area. The dimensional parameters of odontogenic cysts were determined by the linear dimensions of width, height and depth in three mutually perpendicular directions. Analysis of the density and structure of bone tissue in patients with radicular cysts of the jaws was performed according to sectors: frontal sector from canine to canine, premolar area and molar area. The density and structure of the bone tissue in the area of the radicular cyst were examined at distances of 2, 4, and 6 mm from the side wall of the defect, which was in contact with the cyst shell and extended to the periphery.

In all patients, the surgical incision was made in an angular or trapezoidal shape during the cystectomy. A fissure drill was used to facilitate the resection of the apex of the root (if necessary), which was then followed by cystectomy. Subsequently, the mucosal-occipital flap was positioned and secured with sutures.

Statistical analysis of numerical data was carried out using Microsoft Excel 2019 software (Microsoft Office 2019 (Microsoft). All the quantitative data obtained in the study corresponded to the normal type of distribution according to the Shapiro-Wilk's W test, and therefore the interval (M±m) was used to represent their central tendency: arithmetic mean (Mean) ± Standard error. To assess the reliability of the differences in the results obtained in comparison with the control group, the parametric t-test (Student's test) was used. The reliability of the difference in qualitative data between the comparison groups was determined according to the results of calculating the Chi-squared test with Yates's correction for continuity. A value of $p<0.05$ was considered probable.

Results and their discussion.

A total of 60 patients with radicular cysts of the jaws were included in the study. Of these, 58.33% were male and 41.67% were female. Of the age range in groups examined by us, 68.33% of the jaw radicular cysts were most often detected in the age category of 32 to 40 years. Accordingly, at a younger age from 20 to 32 years, the percentage was 16.66%. A much smaller percentage of 15% of radicular cysts among all patients was in the age category from 40 to 50 years.

The analysis of complaints showed that the asymptomatic course of the disease was most prevalent in 71.66%. In 15% of the cases, patients with an anamnesis of the disease were periodically disturbed by spontaneous aching pain in the affected area. In 8.33%, a painful reaction was noted when biting on the teeth in the pathologically changed area. In a small number of patients (5%), a sensitivity in the area of the lower lip and chin (Vincent's symptom) was observed in combination with pain.

A detailed analysis of the location of the cysts showed that the frequency of occurrence of radicular cysts in the upper jaw was 61.66%, as opposed to 38.34% in the lower jaw. On the basis of the radiographs, it was found that the cysts in the upper jaw were most frequently found in the area of the frontal group of teeth: central incisors (21.62%) and lateral incisors (32.43%). They were followed in decreasing frequency by the canines of the upper jaw (18.91%). Radicular cysts were least common in the area of second molars (5.40%), first molars (13.51%) and both maxillary premolars (8.10%) (Figure 3).

When examining the lower jaw, on the contrary, radicular cysts of the jaws most often occurred in the area of molars (34.78%) and premolars (26.08%). Less frequently, radicular cysts of the mandible were found in the frontal region, where the lateral and central incisors accounted for 13.04% and 17.39% respectively. The lowest percentage was found in the mandibular canines. The frequency of cyst formation was only 8.69% (Figure 4).

On the basis of computed tomography data, we analyzed the linear size of radicular cysts of the jaw, which showed that cysts between 10 and 25 mm in size were found in all those examined. The largest percentage of patients (68.33%) were those with cysts up to 15 mm in size. A slightly smaller percentage of

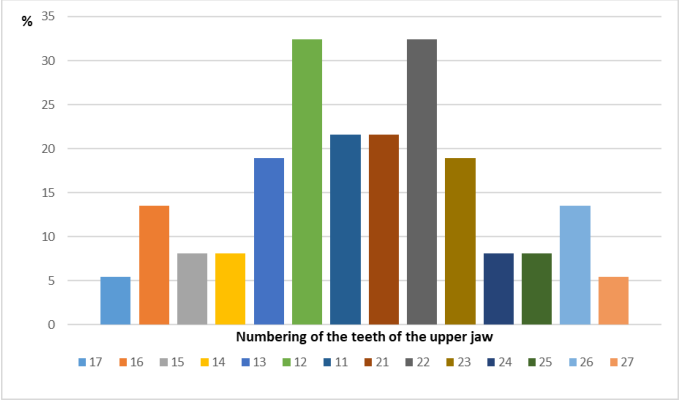

Figure 3. *Frequency (%) of occurrence of radicular cysts on the upper jaw.*

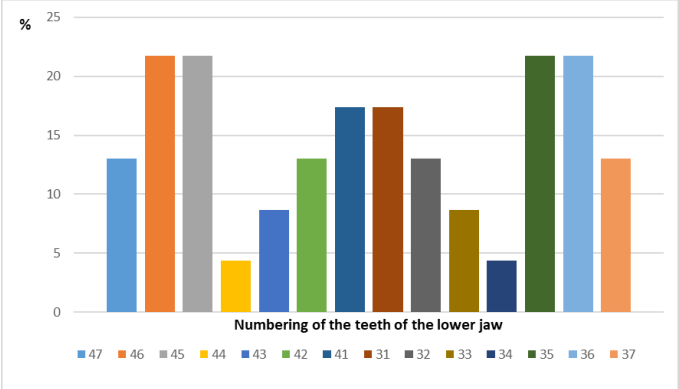

Figure 4. *Frequency (%) of occurrence of radicular cysts on the lower jaw.*

patients (23.33%) had cysts up to 20mm and the remaining 8.34% had the largest cysts up to 25mm.

The density of bone tissue in the areas of direct contact with the cyst shell was greater than the indices of the control group and was within (1134.48+38.61) HU of the frontal and distal areas (745.14+11.40) HU $p<0.001$. In the area from 0 to 2 mm in the frontal zone it corresponded to (1105.17+42.74) HU, and in the distal zone – it was within (678.66+10.56) HU ($p<0.001$). A detailed analysis of the specified area showed signs of osteosclerosis and hyperostosis. In the 4 mm zone, the indices were slightly lower and were within (864.41+30.36) HU ($p>0.05$) in the frontal area and (583.86+33.44) HU ($p<0.01$) in the distal parts of the jaw. In the specified zone, a more compact location of the bone was noted, compared to the intact side. The area with a width of 6 mm, as the most distant one, showed the lowest density index in the frontal (752.34+19.01) HU ($p<0.01$) and in the distal areas of the jaws (513.24+25.70) HU ($p> 0.05$), which was also confirmed by the structure of bone tissue, which practically did not differ from intact bone (Table 1, Figure 5).

The specified density indices were correlated with the structure of bone tissue. As can be seen from the computer tomography data shown in Figure 5, the microstructure of the bone tissue showed a more compact arrangement of the bone trabeculae of the 2 mm zone, compared to the opposite intact area. In contrast to the previous anatomical sections, a compact arrangement of trabeculae was also observed at 4 mm and 6 mm to the periphery.

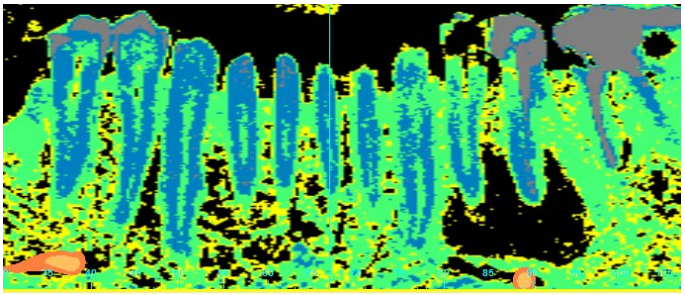

Figure 5. *Patient M is 53 years old. Diagnosis: radicular cyst of the lower jaw on the left in the area of 34, 35 teeth. Computed tomography data (panoramic scan in pseudo-color mode) visualizes the area of increased compaction of bone tissue around the defect of the lower jaw.*

Analysis of clinical data of groups I and II showed some difference between both groups. Thus, on the 3rd day of the examination, all patients of the I and II groups had an increase in collateral edema. However, in 8 (26.66%) patients of the 1st group, for 3-4 days, serous secretions appeared in combination with granules of osteoplastic material along the incision line, in 3 (10%) patients, a slight separation of the sutures was noted. On the other hand, in the II group, only 5 (16.66%) patients had minor serous discharge from the surgical wound, namely, from the incision line, within the above-mentioned period. 6-7 days after cystectomy and bone grafting, only 4 (16.66%) of 8 patients of the I group had minor discharge from the surgical wound, whereas in the II group, the indicated changes were noted only in 2 (6.66%) patients. During the repeated clinical examination on the 12-14th day, only 3 (10%) patients of the I group had some changes, namely the exposure of the membrane and slight discharge of material from the postoperative wound, whereas in the II group, no such changes were noted at the indicated times.

Taking into account the fact that bone grafting in patients of both groups was performed in the absence of pronounced local inflammatory changes in the absence of purulent exudate in the wound, we did not obtain a significant difference in clinical indicators at the final clinical terms.

The analysis of computed tomography data in group I during the 6th month after the surgical intervention showed that in 3 (10%) patients, there were no signs of recovery of the bone defect, which was confirmed by the progression of inflammatory changes in the form of periodically occurring swellings in the operated area and secretions of exudate. In 5 (16.66%) operated patients, there was a violation of the dense wall contact of the granulate, which was noted both on axial sections and on reconstructions, in the form of a small gap of up to 0.4 mm in size between the material and the walls of the defect. In our opinion, in this case, the germination of connective tissue with the subsequent encapsulation of the material took place. Only 13 (43.33%) patients showed signs of complete replacement by bone tissue, which was evidenced by close wall contact of the material with the present zone of osteosclerosis. In the remaining 9 (33.75%) patients, signs of only peripheral recovery of bone tissue with a pronounced granular pattern in the center were noted. The analysis of the bone tissue structure in group I in the area of bone plastic surgery showed pronounced hyperostosis both at 6 and 12 months after bone plastic surgery. The specified

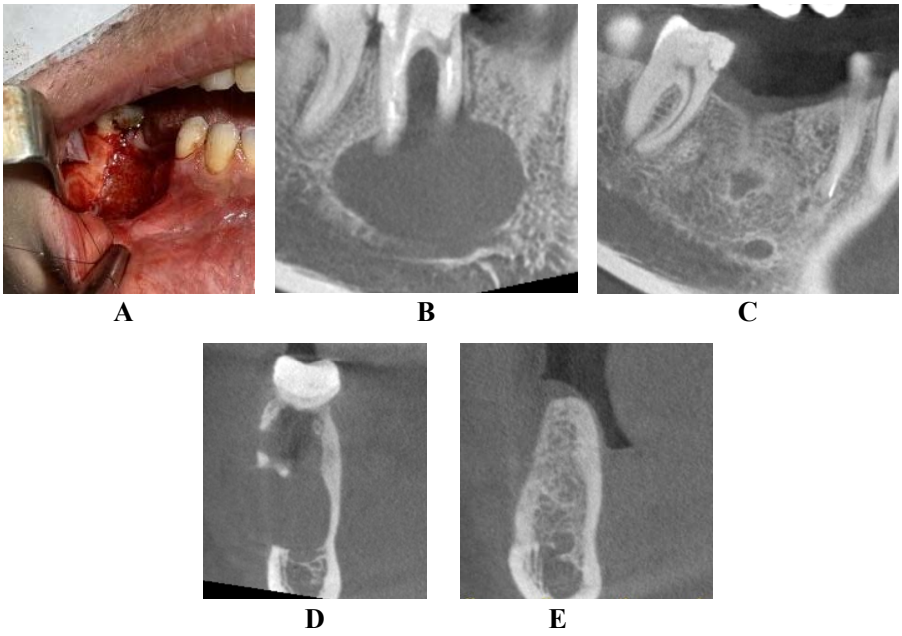

Figure 6. *Patient L., 28 years old. Diagnosis: radicular cyst of the lower jaw on the right in the area of tooth 46. Condition of the patient 8 months after cystectomy and bone grafting in the area of the lower right molars. X-ray examination (computed tomography): A – surgical intervention; B – panoramic scan (before surgery); C – panoramic scan (after surgery); D – transverse reconstruction of the defect site (before surgery); E – transverse reconstruction of the defect site (after surgery).*

Table 1. *Bone density indices in Hounswild units (HU) in patients with radicular cysts of the jaws before the surgical treatment.*

Anatomical areas	**Zones mm**	**Indications for treatment**	**Control**	**Certainty P value**
1	2	3	4	5
Incisors and canines upper jaw	Defect	-	657,24±23,12	-
	0	932,76±16,80		2,6070E-16
	2	883,28±13,51		1,3671E-14
	4	698,07±14,12		0,059234
	6	632,17±18,53		0,379423
Premolars upper jaw	Defect	-	587,97±21,71	-
	0	873,31±22,72		1,3387E-12
	2	735,41±15,03		7,1197E-07
	4	695,55±14,18		0,000115
	6	512,66±18,04		0,009964
Molars upper jaw	Defect	-	475,52±29,06	-
	0	684,48±18,04		1,7437680E-07
	2	565,52±22,09		0,023510
	4	555,97±22,21		0,043779
	6	462,34±29,15		0,660549
Incisors and canines lower jaw	Defect	-	857,62±31,01	-
	0	1134,48±38,61		7,4586E-12
	2	1105,17±42,74		6,6917E-08
	4	864,41±30,36		0,876166
	6	752,34±19,01		0,005399
Premolars lower jaw	Defect	-	654,10±18,43	-
	0	895,07±28,78		2,855030E-09
	2	786,59±17,61		2,9505E-06
	4	662,69±23,80		0,776513
	6	673,59±20,35		0,480892
Molars lower jaw	Defect	-	445,04±27,89	-
	0	745,14±11,40		6,1753E-15
	2	678,66±10,56		1,4553E-10
	4	583,86±33,44		0,002345
	6	513,24±25,70		0,077506

Table 2. *Indices of bone tissue density in Hounswild units (HU) in patients of groups I and II 6 months after surgery.*

Anatomical areas	**Zones mm**	**I group**	**II group**	**I-II group P value**
1	2	4	5	6
Incisors and canines upper jaws	Defect	965,47±21,25	715,18±14,33	2,939800E-06
	0	863,53±14,63	878,16±21,52	0,386377
	2	814,43±15,73	784,21±18,33	0,163067
	4	705,43±18,34	665,42±13,41	0,022883
	6	637,35±17,83	627,25±22,37	0,656999
Premolars upper jaws	Defect	947,64±21,53	672,83±16,43	1,2931E-10
	0	834,57±19,55	813,23±27,63	0,337430
	2	744,62±17,67	703,14±23,51	0,194890
	4	625,74±18,37	644,35±16,62	0,357163
	6	526,35±19,84	477,74±27,34	0,030480
Molars upper jaws	Defect	905,43±21,54	664,27±22,82	1,8511E-11
	0	653,54±19,38	633,53±15,12	0,228161
	2	542,64±19,14	554,13±26,22	0,697411
	4	548,73±23,43	541,72±14,31	0,863478
	6	434,46±25,63	433,27±26,58	0,906377
Incisors and canines lower jaws	Defect	1124,36±39,43	712,25±18,41	5,7059E-15
	0	1195,52±37,43	1171,33±46,31	0,650344
	2	1124,42±38,65	1073,72±36,51	0,225555
	4	835,63±32,53	813,53±32,46	0,364178
	6	718,65±21,73	734,26±17,57	0,349461
Premolars lower jaws	Defect	914,54±26,38	695,13±25,57	1,2782E-07
	0	882,42±23,73	855,72±35,73	0,204464
	2	778,17±21,54	773,12±21,37	0,914263
	4	653,12±19,35	653,74±16,57	0,987619
	6	642,74±19,43	588,42±17,32	0,023697
Molars lower jaws	Defect	876,26±24,67	652,42±27,34	2,2547E-08
	0	743,63±21,78	713,57±22,56	0,150108
	2	662,36±13,45	587,16±24,51	0,003474
	4	553,15±18,47	532,37±25,43	0,389234
	6	521,67±21,63	516,43±21,64	0,802519

Table 3. *Indices of bone tissue density in Hounswild units (HU) in patients of groups I and II 12 months after surgery.*

Anatomical areas	**Zones mm**	**I group**	**II group**	**I-II group P value**
1	2	4	5	6
Incisors and canines upper jaws	Defect	824,62±26,13	676,23±11,18	2,9319E-06
	0	788,16±12,74	754,38±18,43	0,312904
	2	735,64±16,73	714,22±19,32	0,654914
	4	655,21±17,32	625,47±13,75	0,374819
	6	630,56±15,42	617,18±22,25	0,698726
Premolars upper jaws	Defect	725,43±19,45	583,47±17,56	3,1029E-04
	0	718,34±16,72	703,71±19,54	0,623825
	2	684,62±17,26	654,27±18,13	0,261172
	4	577,33±17,27	614,67±21,26	0,372538
	6	495,47±19,53	509,17±15,47	0,632025
Molars upper jaws	Defect	695,67±22,42	492,26±26,71	2,1808E-09
	0	576,18±23,11	584,27±23,16	0,840019
	2	522,21±19,62	489,34±27,42	0,354338
	4	506,43±23,39	475,53±26,71	0,362796
	6	440,21±27,21	445,36±19,73	0,921857
Incisors and canines lower jaws	Defect	934,32±29,16	824,53±32,47	0,000085
	0	938,11±33,73	913,32±34,52	0,369682
	2	885,53±27,67	878,36±32,38	0,821275
	4	782,23±28,54	723,64±16,72	0,018082
	6	708,46±21,73	712,37±17,36	0,831609

Premolars lower jaws	Defect	795,35±19,44	645,57±19,23	3,790111E-07
	0	758,42±18,42	783,41±22,64	0,358368
	2	726,13±22,43	713,16±14,72	0,674138
	4	643,47±24,32	627,53±19,36	0,642279
	6	635,18±19,32	575,65±28,73	0,019178
Molars lower jaws	Defect	724,13±17,71	479,31±26,46	4,8898E-09
	0	625,25±15,73	623,46±22,32	0,988739
	2	573,13±23,73	553,24±17,57	0,462754
	4	472,42±26,33	468,73±21,23	0,843718
	6	464,16±22,73	452,65±19,73	0,624710

type of bone was combined with its pronounced granular pattern, which indicates the presence of material granules that have not yet been resorbed.

6 months after cystectomy and bone grafting, out of 30 patients in group II, 26 (86.66%) had the defect completely restored with bone tissue, while the remaining 4 (13.33%) had bone tissue regeneration of only 2/3 of the bone cavity volume. One year after surgical intervention, bone tissue recovery occurred in all 30 patients. Analysis of the bone tissue structure showed a pronounced trabecular pattern in combination with the presence of a pronounced cortical layer of bone tissue (Figure 6).

Analysis of bone tissue density was performed at the 6th and 12th months after surgery (Tables 2 and 3).

Analyzing the dynamics and nature of growth of bone tissue density indices in the postoperative period in patients with radicular cysts of the jaws, a clear tendency to growth can be observed only in the area of the former bone defect. During the 6th month of the postoperative period, in comparison with the clinical group II, in the group I, the use of granulate based on hydroxyapatite and tricalcium phosphate led to a significant increase in density indices, which did not exceed 49.8% of the indices of the group II. This tendency can be caused, on the one hand, by the untimely resorption of the granulate, on the other hand, by the compact location of the granules, which, in our opinion, led to the compaction of the spongy structure of the bone and the formation of a kind of hyperostosis in the area of bone grafting. During the comparison of indices, a tendency to reduce the difference by almost half between the indices of the groups I and II in the 12-month postoperative period, compared to the same indices, 6 months after the surgical intervention, was also observed. The indicated difference between groups I and II in the one-year postoperative period did not exceed 34.2%, which is associated with a decrease in the bone density of group I. In our opinion, this fact is caused by the final degradation of the material and some decrease in bone compaction due to its reconstruction. Concerning other areas, namely in the zones of direct contact with the shell and distant 2, 4 and 6 mm, no clear tendency in the difference of indices between the two groups and no direct dependence on the group was noted. The only clear dependence was observed between these indices and the postoperative period. The decrease in the density of bone tissue in the areas of contact with the shell from the 6th to the 12th month postoperatively is due to the bone tissue reconstruction, which led to a decrease in its compaction.

Discussion.

Pronounced osteosclerosis and compaction of bone tissue in the 2-6 mm zone around the cyst, in our opinion, may indicate a rapid increase in the volume of the cyst itself, which may lead to a certain mechanical pressure on the adjacent bone tissue, which leads to its compensatory reconstruction. This fact plays a significant role in the case of cystectomy and bone grafting, since the area of compaction and severe osteosclerosis is typically characterized by a paucity of capillary mesh, which can lead to negative results in bone grafting, which is reflected by the lack of bone tissue remodeling in the bone augmentation zone.

It is our contention that the nanofibrous structure of the combined scaffold obtained by us, due to the dense organization of the granules, which was formed during centrifugation due to the design of the filter, the centrifugal force and the strong and stable fibrin matrix, ensured the simultaneous and uniform regeneration of bone tissue over the entire thickness of the defect in group II. This is corroborated by the organized architectonics of bone tissue with a pronounced trabecular pattern, which correlated with bone density indicators, which in this group of patients corresponded to intact bone. In our opinion, this fact is the X-ray confirmation of complete bone regeneration. In group I, in contrast, during the analysis of computer tomography data, pronounced growth from the periphery to the center was noted, which was reflected in some cases by parietal regeneration with a defect in the center. Additionally, the compact structure of the bone was observed to be predominant in group I. This is believed to be due to the presence of material granules that have not yet undergone resorption, which form a compact framework for bone growth. This tendency was confirmed by the works of other authors [4-6]. However, this type of bone tissue, as a rule, is replaced by incomplete bone, which in most cases consists of a small area of newly formed bone tissue that grows between the mineralized granules of the material.

It should also be noted that the difference in the radiological picture between groups I and II when using the same bone-plastic material, in our opinion, is due to the presence of a fibrin framework with growth factors, which creates conditions for the uniform germination of the capillary network throughout the entire volume of the defect and creates conditions for accelerated and uniform simultaneous remodeling of bone tissue. Instead, in group I, on the contrary, the wall contact of the material provides faster regeneration in the bone-material contact zone, as opposed to the centre of such a scaffold, where the sprouting of the capillary network can occur at a later stage and a kind of “dead zone” can be created with faster sprouting of the connective tissue poor in capillaries, which competes with the bone tissue, leading to slower bone remodelling in the central parts.

Conclusion.

1. The obtained results of the X-ray examination of the radicular cyst area indicate pronounced compaction of the bone tissue in the area of contact between the bone tissue and the cyst shell.

2. The filter and technique developed by our research team allow for the creation of a stable combined fibrin scaffold with integrated bone-plastic material.

3. The disparity in bone structure and density between groups I and II demonstrated the discrepancy in bone regeneration. Specifically, group I exhibited the presence of compact bone tissue with a pronounced granular pattern, indicative of an incomplete remodeling process. In contrast, group II displayed a pronounced trabecular pattern, indicative of a complete reconstruction of the implanted bone matrix. This evidence substantiated the efficacy of the applied method.

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