Original Research

https://doi.org/10.36377/ET-0207

Evaluation of the use of materials based on octacalcium phosphate in socket augmentation surgery according to radiological data

Svetlana V. Tarasenko[1], Ekaterina Yu. Diachkova[1], Ilana A. Gor[1], Pavel P. Soloshenkov[1], Aida A. Kazaryan[1] ✉, Dmitry A. Dzyuba[2], Evgeny V. Presnyakov[3]

[1] Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russian Federation

[2] State Research Center – Burnasyan Federal Medical Biophysical Center of Federal Biological Agency, Moscow, Russian Federation

[3] Avtsyn Research Institute of Human Morphology of Petrovsky National Research Centre of Surgery, Moscow, Russian Federation

✉ aya747@mail.ru

Abstract

INTRODUCTION. Modern surgical dentistry is searching for the most effective bone-substituting materials that ensure predictable bone tissue regeneration in the alveolar ridge area. In this context, the domestically produced osteoplastic material “Gistograft” based on octacalcium phosphate granules for socket augmentation is of significant interest due to its use of nucleic acids as molecular triggers for reparative processes. The primary proposed mechanism of action is the stimulation of growth factor expression, among which vascular endothelial growth factor (VEGF) plays a key role.

AIM. To assess bone tissue condition following socket augmentation with an osteoplastic material based on octacalcium phosphate granules using cone-beam computed tomography (CBCT) data.

MATERIALS AND METHODS. The study included 15 patients aged 18 to 45 years with ICD-10 diagnosis K04.5 “Chronic periodontitis” without severe comorbidities. Patients were randomized into two groups. In the first group (8 patients), socket augmentation with synthetic osteoplastic material based on octacalcium phosphate granules was performed after tooth extraction. In the second group (7 patients), no augmentation was performed, and healing occurred under blood clot. Bone tissue condition was assessed by CBCT before surgery and 6 months post-intervention. Statistical analysis was performed using Statistica 6.0 software, with differences considered statistically significant at $p < 0.05$.

RESULTS. In the first group, CBCT data at 6 months post-surgery showed marked positive dynamics with signs of mineralization and integration of octacalcium phosphate granules into surrounding bone tissue. Mean bone height in the defect area increased from 13.4 mm to 16.5 mm, while ridge width remained stable (approximately 5 mm). In the second group, ridge height decreased by an average of 4±2 mm: height decreased from 8.0 mm to 6.4 mm, width from 4.0 mm to 3.3 mm. Statistical analysis revealed significant differences between groups ($p < 0.05$).

CONCLUSION. The use of synthetic osteoplastic material based on octacalcium phosphate granules for socket augmentation allows formation of sufficient bone volume and height for subsequent implant treatment and reduces the need for additional bone grafting procedures.

Keywords: osteoplastic material, socket augmentation, octacalcium phosphate, dental implantation, cone-beam computed tomography, VEGF

Article information: received – 29.03.2026; revised – 03.05.2026; accepted – 20.05.2026

Conflict of interest: The authors declare no conflict of interests.

Acknowledgements: There are no funding and individual acknowledgments to declare.

For citation: Tarasenko S.V., Diachkova E.Yu., Gor I.A., Soloshenkov P.P., Kazaryan A.A., Dzyuba D.A., Presnyakov E.V. Evaluation of the use of materials based on octacalcium phosphate in socket augmentation surgery according to radiological data. *Endodontics Today.* 2026;24(2):437–444. https://doi.org/10.36377/ET-0207

Оценка эффективности применения материалов на основе октакальциевого фосфата при аугментации лунки удаленного зуба по данным лучевых методов исследования

С.В. Тарасенко[1], Е.Ю. Дьячкова[1], И.А. Гор[1], П.П. Солошенков[1], А.А. Казарян[1] ✉, Д.А. Дзюба[2], Е.В. Пресняков[3]

[1] Первый Московский государственный медицинский университет имени И.М. Сеченова» (Сеченовский Университет), г. Москва, Российская Федерация

[2] Государственный научный центр Российской Федерации – Федеральный медицинский биофизический центр имени А.И. Бурназяна Федерального медико-биологического агентства России, г. Москва, Российская Федерация

[3] Научно-исследовательский институт морфологии человека имени академика А.П. Авцына Российского научного центра хирургии имени академика Б.В. Петровского, г. Москва, Российская Федерация

✉ aya747@mail.ru

Резюме

ВВЕДЕНИЕ. В современной хирургической стоматологии продолжается поиск наиболее эффективных костнозамещающих материалов, обеспечивающих предсказуемую регенерацию кости в области альвеолярного отростка и альвеолярной части челюстей. В этом контексте отечественный остеопластический материал «Гистографт» на основе гранул октакальциевого фосфата, предназначенный для аугментации лунки удаленного зуба, представляет значительный интерес благодаря использованию нуклеиновых кислот в качестве молекулярных триггеров репаративных процессов. Основным предполагаемым механизмом действия является стимуляция экспрессии факторов роста, среди которых ключевую роль играет фактор роста эндотелия сосудов (VEGF, Vascular Endothelial Growth Factor).

ЦЕЛЬ. Оценить состояние костной ткани после аугментации лунки остеопластическим материалом на основе гранул октакальциевого фосфата по данным конусно-лучевой компьютерной томографии.

МАТЕРИАЛЫ И МЕТОДЫ. В исследование включены 15 пациентов в возрасте от 18 до 45 лет с диагнозом по МКБ-10 К04.5 «Хронический периодонтит» без тяжелых сопутствующих и хронических заболеваний. Пациенты были рандомизированы на две группы. В первой группе (8 пациентов) после удаления зуба проводили аугментацию лунки синтетическим остеопластическим материалом на основе гранул октакальциевого фосфата. Во второй группе (7 пациентов) аугментацию не выполняли, заживление протекало под кровяным сгустком. Оценку состояния костной ткани осуществляли по данным компьютерной томографии до операции и через 6 месяцев после вмешательства. Статистическую обработку данных проводили с использованием пакета Statistica 6.0, статистически значимыми считали различия при $p < 0,05$.

РЕЗУЛЬТАТЫ. У пациентов первой группы по данным КЛКТ через 6 месяцев после операции отмечали выраженную положительную динамика с признаками минерализации и интеграции гранул октакальциевого фосфата в окружающую костную ткань. Средняя высота костной ткани в зоне дефекта увеличивалась с 13,4 мм до 16,5 мм, ширина альвеолярного гребня оставалась стабильной (около 5 мм). Во второй группе отмечали убыль высоты альвеолярного гребня в среднем на 4±2 мм: высота уменьшалась с 8,0 мм до 6,4 мм, ширина – с 4,0 мм до 3,3 мм. Статистический анализ выявил достоверные различия между группами ($p < 0,05$).

ЗАКЛЮЧЕНИЕ. Применение синтетического остеопластического материала на основе гранул октакальциевого фосфата при аугментации лунки удаленного зуба позволяет сформировать достаточный объем и высоту костной ткани для последующего имплантологического лечения и уменьшить необходимость дополнительных костнопластических вмешательств.

Ключевые слова: остеопластический материал, аугментация лунки зуба, октакальциевый фосфат, дентальная имплантация, конусно-лучевая компьютерная томография, VEGF

Информация о статье: поступила – 29.03.2026; исправлена – 03.05.2026; принята – 20.05.2026

Конфликт интересов: Авторы сообщают об отсутствии конфликта интересов.

Благодарности: Финансирование и индивидуальные благодарности для декларирования отсутствуют.

Для цитирования: Тарасенко С.В., Дьячкова Е.Ю., Гор И.А., Солошенков П.П., Казарян А.А., Дзюба Д.А., Пресняков Е.В. Оценка эффективности применения материалов на основе октакальциевого фосфата при аугментации лунки удаленного зуба по данным лучевых методов исследования. *Эндодонтия Today.* 2026;24(2):437–444. https://doi.org/10.36377/ET-0207

INTRODUCTION

Modern oral surgery places considerable emphasis on the development and implementation of effective bone regeneration techniques, which are of critical importance for treatment planning and execution of dental implant rehabilitation [1–4]. Following tooth extraction, bone remodeling processes are initiated within the alveolar process and the alveolar part of the jawbones, accompanied by physiological resorption of the alveolar bone and subsequent changes in its volume and architectural structure [3–6]. Restoration of adequate bone volume and quality is a key

determinant of successful dental implant placement, while preservation of the alveolar ridge through socket preservation is regarded as one of the principal strategies for preventing pronounced post-extraction atrophy [2–5; 7].

One of the most widely applied surgical procedures aimed at maintaining bone volume and preventing resorptive changes is socket augmentation using various osteoplastic materials [2; 4; 6; 8]. In recent years, increasing attention has been directed toward both autogenous and allogeneic, xenogeneic, and synthetic biomaterials for socket preservation, including β-tricalcium phosphate, hydroxyapatite, collagen-based composites, and novel nanostructured systems [3; 5; 6; 8; 9]. Within this spectrum, materials based on octacalcium phosphate (OCP) are of particular interest, demonstrating promising outcomes in maxillofacial surgery and ridge preservation procedures [9–11].

The domestic material "Histograf" belongs to a class of synthetic osteoplastic compositions based on octacalcium phosphate granules and is characterized by the use of nucleic acids as molecular triggers of reparative processes. It is hypothesized that this material stimulates the expression of growth factors, including vascular endothelial growth factor (VEGF), thereby enhancing angiogenesis and, consequently, bone tissue regeneration [10–13]. VEGF is a key regulator of vascularization, promoting capillary network formation and improving perfusion of regenerating tissues; its role in osteogenesis and bone defect repair has been demonstrated in both experimental and clinical studies [10–13].

It has been shown that precise regulation of VEGF dose and local concentration is critical for the coordinated progression of angiogenesis and osteogenesis, as both deficiency and excessive levels of this factor may impair bone matrix formation and vascular network development [12–14]. Accordingly, the use of osteoplastic materials capable of inducing controlled VEGF expression and supporting angiogenesis within the defect site is considered a promising direction in bone tissue engineering and regenerative dentistry [5;11–14]. Thus, a comprehensive evaluation of the clinical efficacy and radiological characteristics of octacalcium phosphate granule-based materials in post-extraction socket augmentation remains a relevant task in contemporary oral and maxillofacial surgery.

MATERIALS AND METHODS

The study was conducted at the Department of Oral Surgery, Borovsky Institute of Dentistry, Sechenov First Moscow State Medical University. A total of 15 patients of both sexes, aged 18 to 45 years, without decompensated systemic diseases or severe chronic conditions, were included in the study. All patients were diagnosed with ICD-10 code K04.5 ("Chronic apical periodontitis"), which served as an indication for tooth extraction.

Patients were allocated to study groups using a randomization method.

Group 1 (n = 8) included patients in whom socket preservation was performed following tooth extraction using a synthetic osteoplastic material based on octacalcium phosphate granules enriched with vascular endothelial growth factor (VEGF).

Group 2 (n = 7) included patients in whom no socket augmentation was performed, and healing occurred under a blood clot.

All patients underwent cone-beam computed tomography (CBCT) prior to surgery and at 6 months postoperatively to assess bone tissue status and changes in alveolar ridge height and width in the defect area. Linear measurements (ridge height and width) were obtained from standardized CBCT sections. Statistical analysis was performed using Statistica 6.0 software. Normality of data distribution was assessed, and appropriate parametric or non-parametric tests were applied for intergroup comparisons. Differences were considered statistically significant at $p < 0.05$.

SURGICAL PROCEDURE

All surgical interventions were performed under local anesthesia using conduction and infiltration techniques with 4% articaine solution with epinephrine 1 : 100,000 (Articaine 4% with epinephrine 1:100,000, 1.7 mL).

Atraumatic tooth extraction was performed, including root sectioning using a dental bur when necessary, followed by meticulous curettage of the socket until the appearance of pinpoint bleeding.

In Group 1, after socket preparation, augmentation was performed using an osteoplastic material based on octacalcium phosphate granules combined with VEGF. Immediately prior to application, the granules were mixed with sterile saline solution to obtain a moldable consistency, after which the socket was carefully filled with the prepared material. A hemostatic sponge (Alvance) was placed over the graft material and secured with interrupted sutures using Vicryl 4/0 (mean: 3 sutures per case).

Patients in both groups received standard postoperative pharmacological management, including:

– antibiotic therapy (amoxicillin / clavulanate 625 mg twice daily for 7 days);

– non-steroidal anti-inflammatory drugs as needed (nimesulide);

– antihistamine therapy (chloropyramine 25 mg, 1 tablet at night for 3 days).

Clinical follow-up was performed dynamically with assessment of wound healing, presence of inflammatory signs, pain intensity, and patient-reported symptoms. Radiological evaluation was repeated at 6 months to assess the volume and structural characteristics of the regenerated bone tissue (Fig. 1–8).

RESULTS

The study evaluated the clinical course of the postoperative period and radiological outcomes in patients who underwent socket augmentation using an osteoplastic material based on octacalcium phosphate granules (Group 1) and in patients with spontaneous socket healing under a blood clot (Group 2).

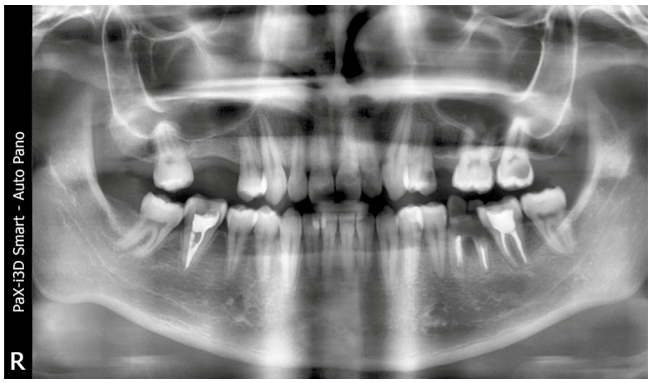

Fig. 1. Patient M (Group 1) diagnosed with chronic apical periodontitis of tooth 3.6

Рис. 1. Пациент М (группа 1), диагноз – хронический периодонтит зуба 3.6

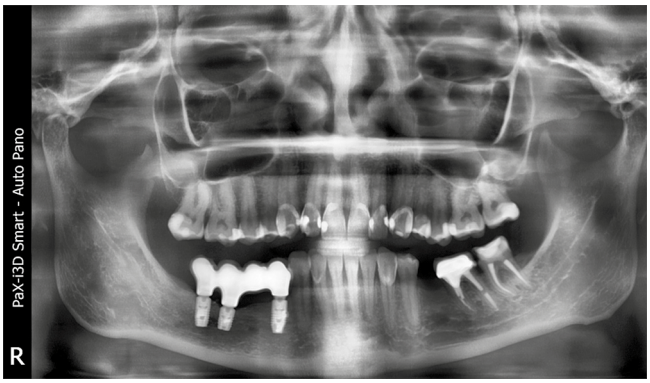

Fig. 3. Patient K (Group 2) diagnosed with chronic apical periodontitis of tooth 3.6

Рис. 3. Пациент К (группа 2), диагноз – хронический периодонтит зуба 3.6

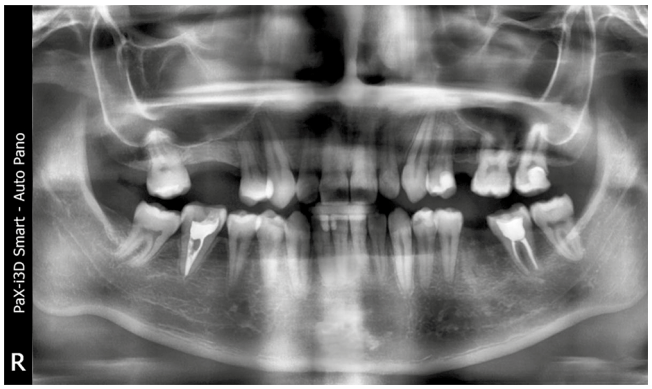

Fig. 2. Patient M (Group 1) after extraction of tooth 3.6 with subsequent socket augmentation procedure

Рис. 2. Пациент М (группа 1): проведено удаление зуба 3.6 с последующей операцией аугментации лунки

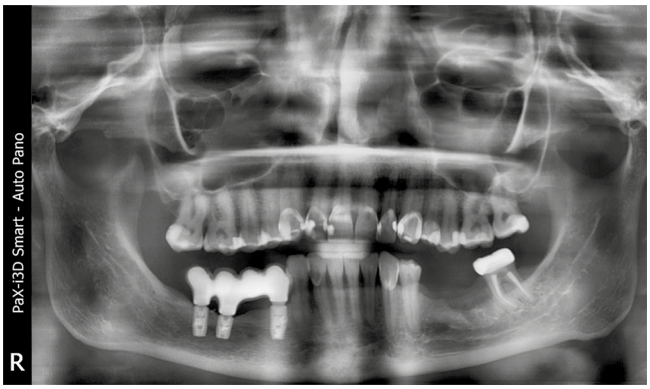

Fig. 4. Patient K (Group 2) after extraction of tooth 3.6 without subsequent socket augmentation

Рис. 4. Пациент К (группа 2): проведено удаление зуба 3.6 без последующей операции аугментации лунки

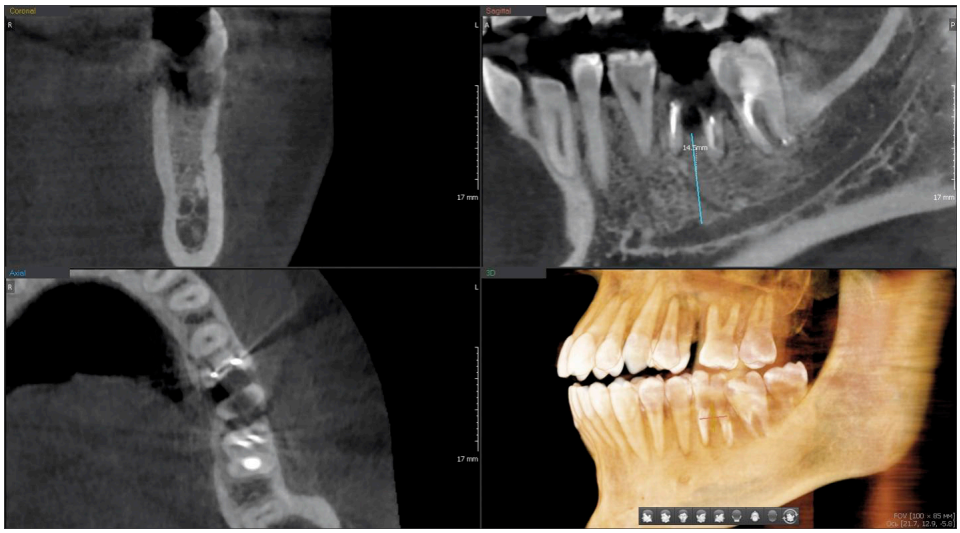

Fig. 5. Patient M (Group 1): CBCT-scan of prior to tooth extraction and socket augmentation (bone height is 14.5 mm to the inferior alveolar nerve)

Рис. 5. Пациент М (группа 1): КЛКТ-снимок пациента до удаления зуба и операции аугментации лунки (костная ткань составляет 14,5 мм до нижнелуночкового нерва)

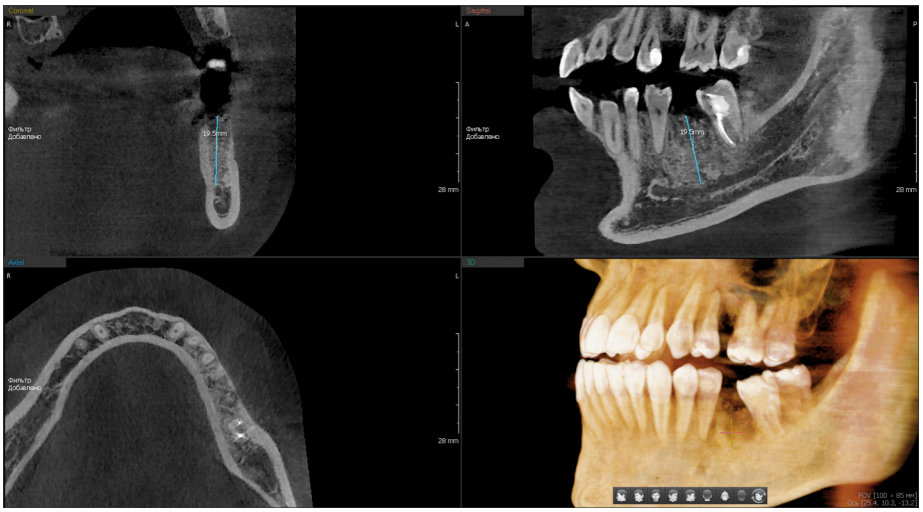

Fig. 6. Patient M (Group 1): CBCT-scan of 6 months after socket augmentation

Рис. 6. Пациент М (группа 1): КЛКТ-снимок спустя 6 месяцев после операции аугментации лунки

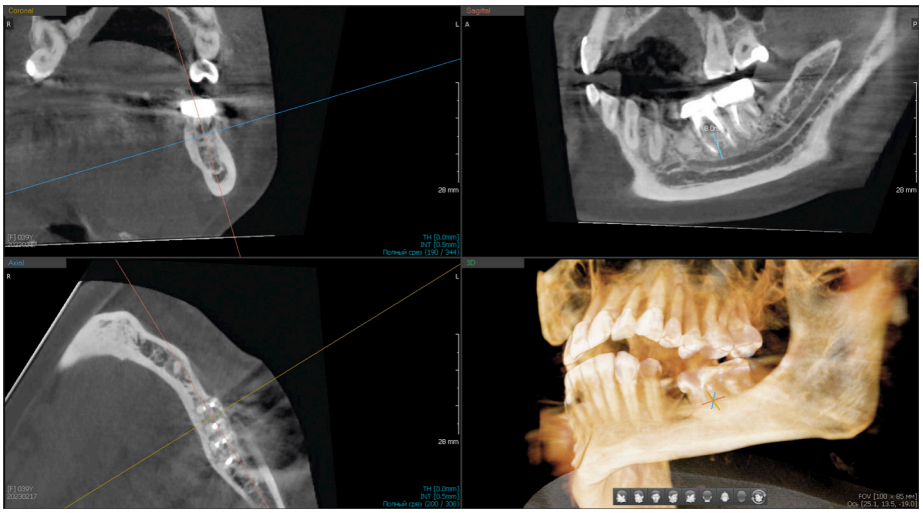

Fig. 7. Patient K (Group 2): CBCT-scan of prior to tooth extraction without subsequent socket augmentation

Рис. 7. Пациент К (группа 2): КЛКТ-снимок до операции удаления зуба без последующей аугметации

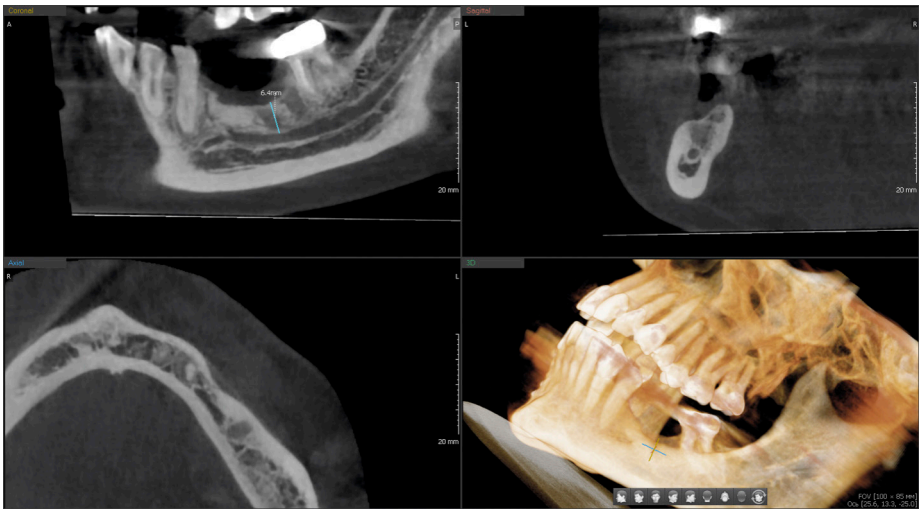

Fig. 8. Patient K (Group 2): CBCT-scan of 6 months after tooth extraction without socket augmentation (healing occurred under a natural blood clot)

Рис. 8. Пациент К (группа 2): КЛКТ-снимок спустя 6 месяцев после удаления, без проведения операции аугментации (заживление под собственным сгустком)

In the overall study cohort, the postoperative period was uneventful in the majority of cases. Mild inflammatory reactions at the surgical site, manifested as soft tissue hyperemia and edema, were observed in three patients and resolved following standard therapy. In one patient from Group 1, graft material rejection occurred due to significant non-compliance with postoperative instructions; this case was excluded from the final analysis.

In Group 1, CBCT evaluation at 6 months postoperatively demonstrated a pronounced positive radiological response, characterized by signs of mineralization and integration of octacalcium phosphate granules into the surrounding bone tissue. The graft particles appeared as areas of increased radiodensity, which gradually became less distinguishable within the newly formed bone matrix, a finding interpreted as evidence of successful osseointegration.

The mean alveolar bone height in the defect region in Group 1 increased from 13.4 ± 1.2 mm to 16.5 ± 1.5 mm, while the alveolar ridge width remained stable (5.0 ± 0.5 mm). The mean vertical bone gain was 3.1 ± 0.8 mm.

In Group 2, in which spontaneous healing occurred under a blood clot, CBCT data at 6 months demonstrated a reduction in alveolar ridge height of 4.0 ± 2.0 mm on average. Bone height decreased from 8.0 ± 1.5 mm to 6.4 ± 1.8 mm, while ridge width decreased from 4.0 ± 0.8 mm to 3.3 ± 0.9 mm. In several cases, the resulting bone volume was insufficient for subsequent dental implant placement without additional bone augmentation procedures.

Statistical analysis revealed significant differences in newly formed bone parameters between the augmentation group and the spontaneous healing group ($p < 0.05$), indicating more favorable conditions for subsequent implant rehabilitation when an octacalcium phosphate–based osteoplastic material was used.

DISCUSSION

The obtained results demonstrate that the use of an osteoplastic material based on octacalcium phosphate granules for socket augmentation after tooth extraction contributes to the preservation and increase of alveolar ridge height compared with spontaneous healing under a blood clot. These findings are consistent with previously published data on ridge preservation techniques employing various synthetic and xenogeneic biomaterials [2–4; 6; 8; 9]. A number of clinical and experimental studies have shown that socket filling with biomaterials reduces both horizontal and vertical ridge resorption and improves conditions for subsequent implant placement [2; 3; 6; 8; 9].

The present results are in agreement with previously reported outcomes on octacalcium phosphate (OCP)-based materials, including OCP–collagen composites, which have demonstrated the formation of highly vascularized bone tissue with a pronounced type H vascular network and favorable morphometric characteristics [9–11]. The observed increase in alveolar ridge height and maintenance of ridge width in the augmentation group in the present study provide more favorable conditions for optimal implant positioning without the need for additional bone grafting procedures, which is of significant clinical relevance [2–4; 8; 9].

The proposed mechanism of action of the “Histograf” material, involving stimulation of VEGF expression and enhancement of angiogenesis, is consistent with the current concept of osteoangiogenesis coupling, according to which successful bone regeneration is critically dependent on the coordinated formation of vascular and bone tissue compartments [10–13; 15]. Experimental studies have demonstrated that local delivery of VEGF or the use of biomaterials capable of inducing its expression promotes accelerated neovascularization, increased bone mineral density, and improved structural organization of bone in defect sites [10; 12; 13; 15]. At the same time, it is emphasized that the dose and release kinetics of VEGF must be carefully controlled, as excessive angiogenic stimulation may lead to the formation of immature or excessively vascularized tissue with impaired osteogenic potential [12; 13; 15].

In the present study, the superior clinical and radiological outcomes observed in the augmentation group may be attributed to the combined osteoconductive properties of OCP granules and an additional angiogenic effect mediated through VEGF-dependent mechanisms. Such a combination of osteoconduction and controlled osteoinduction is currently considered one of the key directions in the development of advanced bone substitute materials [5; 11–13; 15]. Furthermore, the use of CBCT as a quantitative method for assessing bone volume and architecture is consistent with contemporary recommendations for standardized radiological evaluation of alveolar ridge preservation procedures [3; 4; 6; 8; 16].

The main limitations of this study include the relatively small sample size and the limited follow-up period (6 months), which do not allow for assessment of long-term implant outcomes and the stability of alveolar ridge parameters. Definitive validation of the clinical efficacy of octacalcium phosphate–based materials requires larger randomized controlled trials with extended follow-up periods, as well as inclusion of histological evaluation of regenerated bone, as reported in recent studies on OCP composites and growth factor-releasing biomaterials [9–13; 15].

CONCLUSION

Based on clinical and radiological assessments, socket augmentation using a synthetic osteoplastic material based on octacalcium phosphate granules demonstrated a statistically significant advantage over spontaneous healing under a blood clot in terms of preservation and restoration of alveolar bone volume.

The material promotes a stable increase in alveolar ridge height, as confirmed by CBCT findings at 6 months postoperatively.

The use of an octacalcium phosphate-based osteoplastic material enriched with vascular endothelial growth factor (VEGF) optimizes conditions for subsequent implant rehabilitation and, in selected cases, may eliminate the need for additional bone augmentation procedures.

REFERENCES / СПИСОК ЛИТЕРАТУРЫ

1. Drobishev A.Yu., Rubina K.A., Sysoeva V.Yu., Kalinina N.I., Grigor'ev O.A., Melerzanov A.V. et al. Pilot clinical trial of tissue engineered constructs consisting of autologous stromal cells from adipose tissue in patients with bone tissue deficiency in the field of the alveolar process of maxilla and mandible. *Journal of Experimental and Clinical Surgery*. 2011;4(4):764–772. (In Russ.) Available at: https://vestnik-surgery.com/journal/article/view/326 (accessed: 20.04.2026).
   Дробышев А.Ю., Рубина К.А., Сысоева В.Ю., Калинина Н.И., Григорьева О.А., Мелерзанов А.В. и др. Клиническое исследование применения ткане-инженерной конструкции на основе аутологичных стромальных клеток из жировой ткани у пациентов с дефицитом костной ткани в области альвеолярного отростка верхней челюсти и альвеолярной части нижней челюсти. *Вестник экспериментальной и клинической хирургии*. 2011;4(4):764–772. Режим доступа: https://vestnik-surgery.com/journal/article/view/326 (дата обращения: 20.04.2026).
2. Lekishvili M.V., Rodionova S.S., Il'ina V.K., Kasymov L.A., Yurasova Yu.B., Semenova L.A., Vasiliev M.G. Main characteristics of demineralized bone allografts produced at CITO tissue bank. *N.N. Priorov Journal of Traumatology and Orthopedics.* 2007;(3):80–86. (In Russ.)
   Лекишвили М.В., Родионова С.С., Ильина В.К., Косымов И.А., Юрасова Ю.Б., Семенова Л.А., Васильев М.Г. Основные свойства деминерализованных костных аллоимплантатов, изготавливаемых в тканевом банке ЦИТО. *Вестник травматологии и ортопедии им. Н.Н. Приорова*. 2007;(3):80–86.
3. Saleeva G.T., Yarulina Z.I., Sedov Yu.G., Mikhalev P.N. Clinical and radiological evaluation of jaw bone augmentation according to the cone-beam CT. *Vestnik Sovremennoi Klinicheskoi Mediciny.* 2014;7(2):27–31. (In Russ.)
   Салеева Г.Т., Ярулина З.И., Седов Ю.Г., Михалев П.Н. Клинико-лучевая оценка наращивания костной ткани челюстей по данным конусно-лучевой компьютерной томографии. *Вестник современной клинической медицины*. 2014;7(2):27–31.
4. Serova N.S., Goncharov I.Y., Perova N.G., Kapranov M.Y. Radiology diagnostics in planning and monitoring of bone reconstructive operations before dental implantation. *Kuban Scientific Medical Bulletin.* 2010;(6):129–134. (In Russ.)
   Серова Н.С., Гончаров И.Ю., Перова Н.Г., Капранов М.Ю. Лучевая диагностика в планировании и контроле костно-реконструктивных операций перед стоматологической имплантацией. *Кубанский научный медицинский вестник*. 2010;(6):129–134.
5. Ushakov A.I., Serova N.S., Ushakov A.A., Yur'ev E.M., Perova N.G. Diagnostic imaging in implant dentistry in case of bone deficiency. *Russian Electronic Journal of Radiology.* 2014;4(2):86–96. (In Russ.)
   Ушаков А.И., Серова Н.С., Ушаков А.А., Юрьев Е.М., Перова Н.Г. Лучевая диагностика при дентальной имплантации в условиях дефицита костной ткани. *Российский электронный журнал лучевой диагностики.* 2014;4(2):86–96.
6. Tarasenko S.V., Serova N.S., Ershova A.M. Comparative analysis of synthetic and xenogeneic osteoplastic materials application for augmentation of the alveolar process / part of the jaws before dental implantation according to the radiology methods. *Russian Electronic Journal of Radiology.* 2017;7(2):21–30. (In Russ.) https://doi.org/10.21569/2222-7415-2017-7-2-21-30
   Тарасенко С.В., Серова Н.С., Ершова А.М. Сравнительный анализ применения синтетических и ксеногенных остеопластических материалов для аугментации альвеолярного отростка/ части челюстей перед дентальной имплантацией по данным лучевых методов обследования. *Российский электронный журнал лучевой диагностики.* 2017;7(2):21–30. https://doi.org/10.21569/2222-7415-2017-7-2-21-30
7. Pranskunas M., Galindo-Moreno P., Padial-Molina M. Extraction socket preservation using growth factors and stem cells: a systematic review. *J Oral Maxillofac Res*. 2019;10(3):e7. https://doi.org/10.5037/jomr.2019.10307
8. Wróbel P., Piecuch A., Bąk M., Krynicki P., Adamczyk J., Mojżesz P. et al. Evaluation of the effectiveness of the socket preservation technique using allogeneic and xenogeneic materials – a preliminary study. *J Funct Biomater*. 2025;16(6):192. https://doi.org/10.3390/jfb16060192
9. Das S., Jhingran R., Bains V.K., Madan R., Srivastava R., Rizvi I. Socket preservation by beta-tri-calcium phosphate with collagen compared to platelet-rich fibrin: A clinico-radiographic study. *Eur J Dent*. 2016;10(2):264–276. https://doi.org/10.4103/1305-7456.178298
10. Jonker B.P., Gil A., Naenni N., Jung R.E., Wolvius E.B., Pijpe J. Soft tissue contour and radiographic evaluation of ridge preservation in early implant placement: A randomized controlled clinical trial. *Clin Oral Implants Res*. 2021;32(1):123–133. https://doi.org/10.1111/clr.13686
11. Kawai T., Kamakura S., Matsui K., Fukuda M., Takano H., Iino M. et al. Clinical study of octacalcium phosphate and collagen composite in oral and maxillofacial surgery. *J Tissue Eng*. 2020;11:2041731419896449. https://doi.org/10.1177/2041731419896449
12. Kaida N., Matsunaga S., Tachiki C., Otsu Y., Sugahara K., Kasahara N. et al . Ridge preservation using octacalcium phosphate collagen to induce new bone containing a vascular network of mainly Type H vessels. *Sci Rep*. 2024;14(1):25335. https://doi.org/10.1038/s41598-024-75931-y
13. Street J., Bao M., de Guzman L., Bunting S., Peale F.V. Jr, Ferrara N. et al. Vascular endothelial growth factor stimulates bone repair by promoting angiogenesis and bone turnover. *Proc Natl Acad Sci U S A*. 2002;99(15):9656–9661. https://doi.org/10.1073/pnas.152324099
14. Grosso A., Lunger A., Burger M.G., Briquez P.S., Mai F., Hubbell J.A. et al. VEGF dose controls the coupling of angiogenesis and osteogenesis in engineered bone. *NPJ Regen Med*. 2023;8(1):15. https://doi.org/10.1038/s41536-023-00288-1
15. Li B., Wang H., Zhou G., Zhang J., Su X., Huang Z. et al. VEGF-loaded biomimetic scaffolds: a promising approach to improve angiogenesis and osteogenesis in an ischemic environment. *RSC Adv.* 2017;7(8):4253–4259. https://doi.org/10.1039/C6RA25294J
16. Xia Y., Xie L., Zhou Y., Song T., Zhang F., Gu N. A new method to standardize CBCT for quantitative evaluation of alveolar ridge preservation in the mandible: a case report and review of the literature. *Regen Biomater*. 2015;2(4):251–260. https://doi.org/10.1093/rb/rbv017

INFORMATION ABOUT THE AUTHORS

Svetlana V. Tarasenko – Dr. Sci. (Med.), Professor, Head of the Department of Oral Surgery, E.V. Borovsky Institute of Dentistry, Sechenov First Moscow State Medical University (Sechenov University), 8c2 Trubetskaya Str., Moscow 119048, Russian Federation; https://orcid.org/0000-0001-8595-8864

Ekaterina Yu. Diachkova – Dr. Sci. (Med.), Professor, Department of Oral Surgery, E.V. Borovsky Institute of Dentistry, Sechenov First Moscow State Medical University (Sechenov University), 8c2 Trubetskaya Str., Moscow 119048, Russian Federation; https://orcid.org/0000-0003-4388-8911

Ilana A. Gor – Cand. Sci. (Med.), Associate Professor, Department of Oral Surgery, E.V. Borovsky Institute of Dentistry, Sechenov First Moscow State Medical University (Sechenov University), 8c2 Trubetskaya Str., Moscow 119048, Russian Federation; https://orcid.org/0000-0003-0585-4518

Pavel P. Soloshenkov – Cand. Sci. (Med.), Assistant Professor, Department of Maxillofacial Surgery; Oral and Maxillofacial Surgeon, E.V. Borovsky Institute of Dentistry, Sechenov First Moscow State Medical University (Sechenov University), 8c2 Trubetskaya Str., Moscow 119048, Russian Federation; https://orcid.org/0000-0002-3844-0082

Aida A. Kazaryan – Postgraduate Student, Department of Oral Surgery, E.V. Borovsky Institute of Dentistry, Sechenov First Moscow State Medical University (Sechenov University), 8c2 Trubetskaya Str., Moscow 119048, Russian Federation; https://orcid.org/0009-0007-9699-8555

Dmitry A. Dzyuba – Resident, Department of Oral Surgery, State Research Center – Burnasyan Federal Medical Biophysical Center of Federal Biological Agency, 46 Zhivopisnaya St., Moscow 123098, Russian Federation; https://orcid.org/0009-0008-5917-284X

Evgeny V. Presnyakov – Researcher, Laboratory of Morphology and Pathology of the Musculoskeletal System, Avtsyn Research Institute of Human Morphology of Petrovsky National Research Centre of Surgery, 3 Tsyurupy Str., Moscow 117418, Russian Federation; https://orcid.org/0000-0003-1546-5129

ИНФОРМАЦИЯ ОБ АВТОРАХ

Тарасенко Светлана Викторовна – д.м.н., профессор, заведующий кафедрой хирургической стоматологии Института стоматологии им. Е.В. Боровского, ФГАОУ ВО «Первый Московский государственный медицинский университет имени И.М. Сеченова» (Сеченовский Университет), 119048, Российская Федерация, г. Москва, Трубецкая ул., д. 8, стр. 2; https://orcid.org/0000-0001-8595-8864

Дьячкова Екатерина Юрьевна – д.м.н., профессор кафедры хирургической стоматологии Института стоматологии им. Е.В. Боровского, ФГАОУ ВО «Первый Московский государственный медицинский университет имени И.М. Сеченова» (Сеченовский Университет), 119048, Российская Федерация, г. Москва, Трубецкая ул., д. 8, стр. 2; https://orcid.org/0000-0003-4388-8911

Гор Илана Александровна – к.м.н., доцент кафедры хирургической стоматологии Института стоматологии им. Е.В. Боровского, ФГАОУ ВО «Первый Московский государственный медицинский университет имени И.М. Сеченова» (Сеченовский Университет), 119048, Российская Федерация, г. Москва, Трубецкая ул., д. 8, стр. 2; https://orcid.org/0000-0003-0585-4518

Солошенков Павел Петрович – к.м.н., ассистент кафедры челюстно-лицевой хирургии, врач-челюстно-лицевой хирург Института стоматологии им. Е.В. Боровского, ФГАОУ ВО «Первый Московский государственный медицинский университет имени И.М. Сеченова» (Сеченовский Университет), 119048, Российская Федерация, г. Москва, Трубецкая ул., д. 8, стр. 2; https://orcid.org/0000-0002-3844-0082

Казарян Аида Арсеновна – аспирант кафедры хирургической стоматологии Института стоматологии им. Е.В. Боровского, ФГАОУ ВО «Первый Московский государственный медицинский университет имени И.М. Сеченова» (Сеченовский Университет), 119048, Российская Федерация, г. Москва, Трубецкая ул., д. 8 стр. 2; https://orcid.org/0009-0007-9699-8555

Дзюба Дмитрий Анатольевич – ординатор кафедры хирургической стоматологии, ФГБУ «Государственный научный центр Российской Федерации – Федеральный медицинский биофизический центр имени А.И. Бурназяна» Федерального медико-биологического агентства России, 123098, Российская Федерация, г. Москва, ул. Живописная, д. 46; https://orcid.org/0009-0008-5917-284X

Пресняков Евгений Валерьевич – научный сотрудник лаборатории морфологии и патологии опорно-двигательного аппарата, Научно-исследовательский институт морфологии человека имени академика А.П. Авцына ФГБНУ «Российский научный центр хирургии имени академика Б.В. Петровского», 117418, Российская Федерация, г. Москва, ул. Цюрупы, д. 3; https://orcid.org/0000-0003-1546-5129

AUTHOR'S CONTRIBUTION

All the authors made equal contributions to the publication preparation in terms of the idea and design of the article; data collection; critical revision of the article in terms of significant intellectual content and final approval of the version of the article for publication.

ВКЛАД АВТОРОВ

Все авторы внесли равноценный вклад в подготовку публикации в части замысла и дизайна исследования; сбора данных; критического пересмотра статьи в части значимого интеллектуального содержания и окончательного одобрения варианта статьи для опубликования.