

Case report

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Use of Nano-Osteoperforations in Patients With Maxillary and Mandibular Arch Constriction and Mandibular Incisor Crowding

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ABSTRACT

Orthodontic treatment is intended to correct malocclusion and dentofacial anomalies. In many cases, conventional orthodontic techniques prove insufficient or require extended treatment durations. In such instances, minimally invasive surgical interventions offer an alternative therapeutic strategy. Micro-osteoperforation, commonly performed using rotary burs, often results in trauma to the oral mucosa. We propose a method of nano-osteoperforation that enables a minimally traumatic approach. This article presents a clinical case demonstrating the application of nano-osteoperforations during orthodontic treatment in patients with maxillary and mandibular arch constriction and mandibular incisor crowding. Nano-osteoperforation is an innovative technique aimed at promoting bone regeneration and accelerating orthodontic tooth movement. In this case, the use of nano-osteoperforations facilitated faster treatment progression and improved smile aesthetics.

Keywords: nano-osteoperforation; dental arch constriction; orthodontic treatment; mandibular incisor crowding.

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Применение нано-остеоперфораций у пациентов с сужением зубного ряда верхней и нижней челюсти и тесным положением нижних резцов

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АННОТАЦИЯ

Ортодонтическое лечение направлено на коррекцию неправильного прикуса и аномалий зубочелюстного аппарата. Довольно часто традиционные ортодонтические методы недостаточно эффективны или требуют длительной коррекции. В таких случаях применение мало инвазивных хирургических методов позволяет пациентам выбрать альтернативный план лечения. Использование в лечении микроостеоперфораций часто осуществляется с применением боров, что вызывает травматизацию слизистой оболочки полости рта. Нами был предложен метод нано-остеоперфораций, который позволяет проводить атравматичную процедуру. В данной статье приведен клинический пример применения нано-остеоперфораций на этапе ортодонтического лечения у пациентов с сужением зубного ряда верхней и нижней челюстей и тесным положением нижних резцов. Нано-остеоперфорации представляют собой инновационный метод, направленный на стимуляцию регенерации костной ткани и ускорение ортодонтического перемещения зубов. В данном клиническом примере применение нано-остеоперфораций позволило достичь желаемого результата в более короткие сроки и улучшить эстетику улыбки пациента.

Ключевые слова: нано-остеоперфорации; сужение зубного ряда; ортодонтическое лечение; тесное положение нижних резцов.

Как цитировать

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INTRODUCTION

The diagnosis and treatment of maxillary and mandibular arch constriction and lower incisor crowding is an important issue in modern dentistry [1]. These anomalies have a multifactorial etiology, including genetic predisposition, disturbances in craniofacial development, and various jaw growth anomalies [2].

Lower incisor crowding not only compromises esthetics, but also causes functional disorders such as difficulty biting and impaired articulation. Moreover, it increases the risk of injuries to the teeth and dental caries. These factors highlight the importance of early diagnosis and comprehensive treatment in this type of condition [3].

Orthodontic treatment is intended to correct malocclusion and dentofacial anomalies. In many cases, conventional orthodontic techniques are inefficient or require long-term treatment. In these cases, surgical interventions can be a valuable additional option, significantly improving orthodontic treatment outcomes [4–6].

The proposed nano-osteoperforation technique is a surgical procedure that facilitates tooth movement, stimulates blood circulation and bone tissue regeneration. It involves making small openings (1.1–1.5 mm in diameter) in the maxillary and mandibular cortical and cancellous bones with a osteoperforation device patented by Shchedrina, Fadeev, and Prozorova (utility model patent No. 225784 of May 6, 2024, Russia).

CASE DESCRIPTION

Patient B., female, 35 years old, presented to the Romanovsky Medical Center with complaints of pain and clicking in the temporomandibular joint (TMJ), bruxism, primary headaches, and misaligned teeth.

On examination: attrition of upper and lower incisal edges, cusps of canine teeth, and occlusal surfaces of molars. V-shaped constriction of the maxillary arch. Crowding of the upper and lower incisors. The maxillary and mandibular labial frenula and the buccal frenula are attached at the center of the alveolar part. Overeruption of tooth 14 (ISO 21). Occlusal plane deformation. The overjet measures 11.6 mm. The maxillary midline is displaced 3.5 mm to the left relative to the facial midline. Angle Class II molar relationships. TMJ clicking on the left when opening the mouth. TMJ clicking and popping on the left on palpation via the external auditory meatus. The medial pterygoid muscle on the right is mildly tender on palpation. The lateral pterygoid muscle on the right and left is tender on palpation. The posterior discotemporal ligament on the left is tender on palpation. When swallowing saliva, the tongue is positioned between the upper and lower teeth (Figs. 1–3).

Computed tomography (CT) of the jaws, lateral cephalometric radiographs, TMJ CT, and functional diagnostic tests were performed (Figs. 4–6).

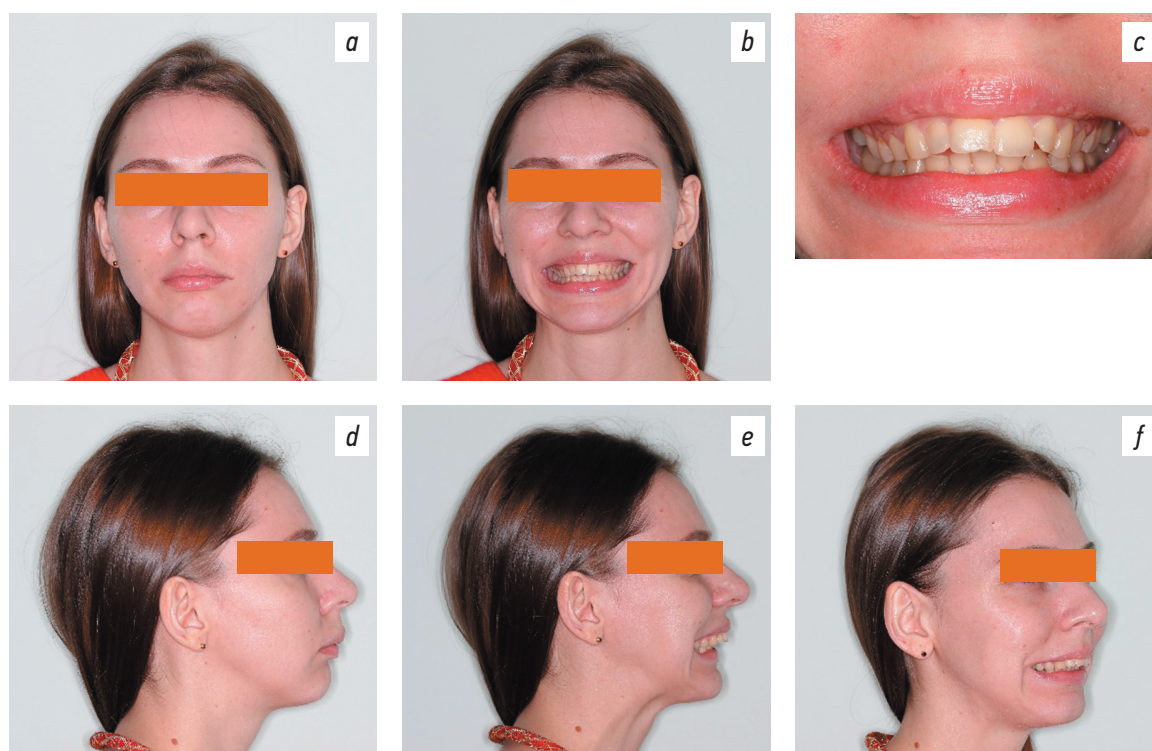


Fig. 1. Photo of the patient's face: frontal view (a), with a smile (b), photo of a smile (c), profile view (d), profile view with a smile (e), three-quarter view with a smile (f).

Рис. 1. Фотография лица пациентки: анфас (a), с улыбкой (b), фотография улыбки (c), в профиль (d), в профиль с улыбкой (e), в $3/4$ оборота с улыбкой (f).



Fig. 2. Dental arches: lateral right projection (a), posteroanterior projection (b), lateral left projection (c).

Рис. 2. Зубные ряды: боковая правая проекция (a), передняя проекция (b), боковая левая проекция (c).

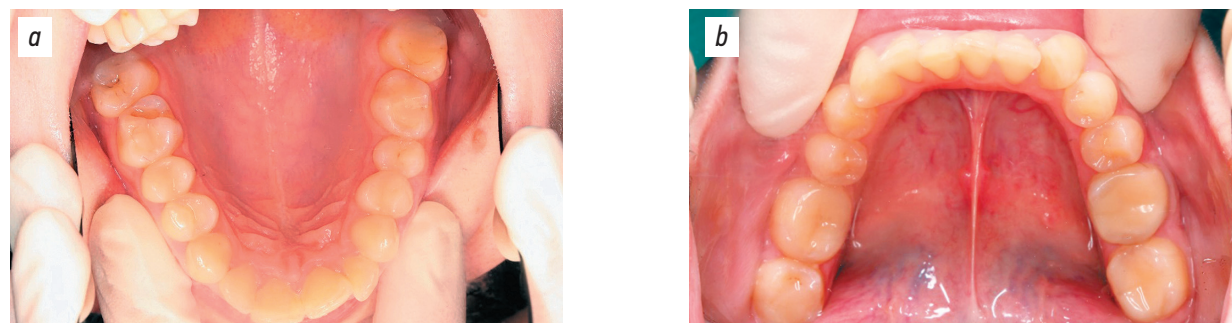


Fig. 3. Occlusal projection of the upper arch (a) and the lower arch (b).

Рис. 3. Оклюзионная проекция верхнего зубного ряда (a) и нижнего зубного ряда (b).

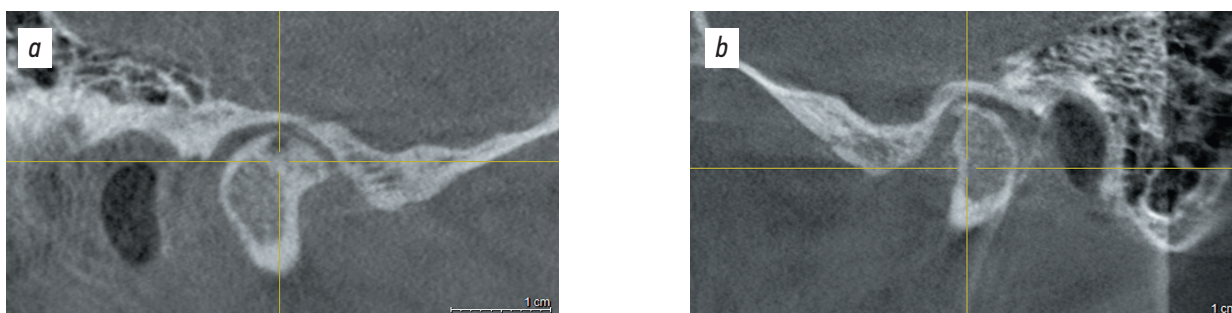


Fig. 4. Computed tomography sections of the right (a) and left (b) temporomandibular joints before treatment.

Рис. 4. Срез компьютерной томограммы правого (a) и левого (b) височно-нижнечелюстного сустава до лечения.



Fig. 5. Section of computed tomography of the jaws before treatment.

Рис. 5. Срез компьютерной томограммы челюстей до лечения.



Fig. 6. Lateral cephalometric radiograph before treatment.

Рис. 6. Телерентгенограмма в боковой проекции до лечения.

The functional diagnostic tests revealed hypertonicity of the masticatory muscles: right temporalis (RTA), 4.2 μ V; left temporalis (LTA), 4.3 μ V; right masseter (RMM), 7 μ V; left masseter (LMM), 3.5 μ V. Following TENS therapy, the amplitude of the temporal and masseter muscles

improved, and hypertonicity reduced relative to mean values: RTA, 3 μ V; LTA, 3 μ V; RMM, 3.5 μ V; LMM, 2 μ V.

The following diagnosis was made based on these findings: TMJ osteoarthritis. Masticatory muscle para-function. Angle Class II molar relationships. Mandibular



Fig. 7. Dental arches with mouth guard: lateral right projection (a); posteroanterior projection (b); lateral left projection (c).

Рис. 7. Зубные ряды с каппой: боковая правая проекция (a); прямая проекция (b); боковая левая проекция (c).

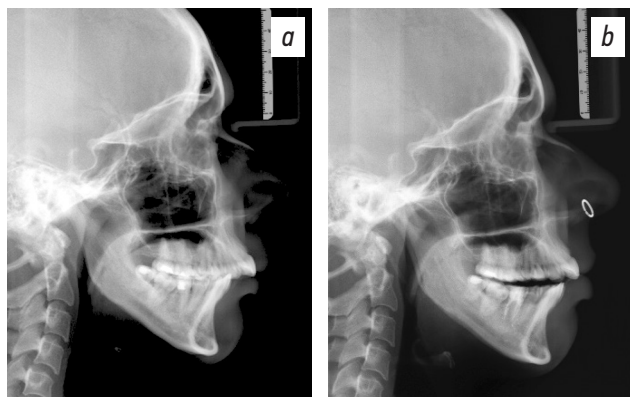


Fig. 8. Lateral cephalometric radiograph: before (a) and after (b) using the mouth guard.

Рис. 8. Телерентгенограмма в боковой проекции до (a) и после (b) использования каппы.

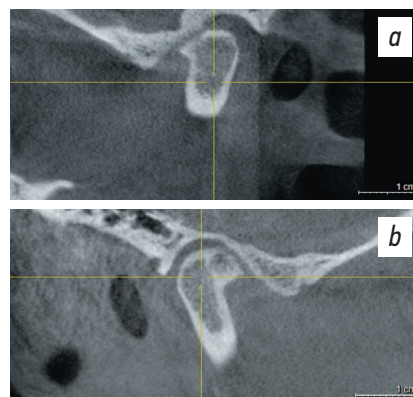


Fig. 9. Section of a computed tomogram of the right (a) and left (b) temporomandibular joints after using a mouth guard.

Рис. 9. Срез компьютерной томограммы правого (a) и левого височно-нижнечелюстного сустава (b) после использования каппы.



Fig. 10. Dental arches after braces placement, lateral right projection (a), posteroanterior projection (b), left side projection (c).

Рис. 10. Зубные ряды после установления брекет-системы: боковая правая проекция (a), передняя проекция (b), боковая левая проекция (c).

retrognathia. Anterior inclination of the mandible. Vertical growth pattern. Upper and lower incisor protrusion and crowding. Maxillary arch constriction. Impacted tooth 17, missing tooth 30 (ISO designations 38 and 46, respectively). Mesial inclination of teeth 32 and 31 (ISO designations 48 and 47, respectively). Localized excessive attrition of teeth. Occlusal plane deformation. Tongue parafunction. Chronic periodontitis of tooth 19 (ISO designation 36).

Following additional examinations, the treatment plan was proposed, which included occlusal splints and orthodontic treatment.

After wearing occlusal splints for 6 months (Fig. 7), a follow-up lateral cephalogram was performed. When comparing the scans, anterior displacement of the mandible was detected (Fig. 8).

A follow-up TMJ CT was performed after wearing occlusal splints (Fig. 9).

Empower braces (CuNiTi 0.14; American Orthodontics, USA) were installed on the maxilla (Figs. 10, 11).

One month after braces were installed on the maxilla, nano-osteoperforation of the roots of teeth 7, 6, 9, 10, and 11 (ISO designations 12, 13, 21, 22, and 23, respectively) was performed, and a BioEdge 16×16 archwire was installed (Fig. 12).

After installing braces on the mandible, nano-osteoperforation in FDI quadrants 3 and 4 was performed. Figs. 13 and 14 show the effect of nano-osteoperforation after 4 weeks of orthodontic treatment.

Orthodontic microimplants were then placed in FDI quadrants 1 and 2 for occlusal plane correction (Figs. 15, 16).

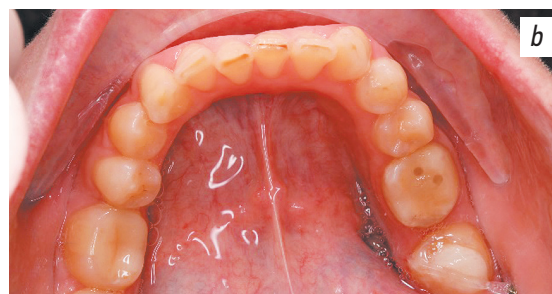


Fig. 11. Occlusal projection: the upper (a) and the lower (b) dental arches.

Рис. 11. Оклюзионная проекция верхнего (a) и нижнего (b) зубных рядов.



Fig. 12. Dental arches after nano-osteoperforations: right lateral projection (a), posteroanterior projection (b), left lateral projection (c).

Рис. 12. Зубные ряды после нано-остеоперфораций: боковая правая проекция (a), прямая проекция (b), боковая левая проекция (c).

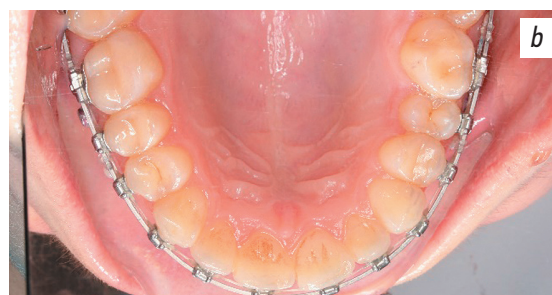


Fig. 13. Occlusal projection of the upper dental arch before (a) and after (b) nano-osteoperforations.

Рис. 13. Оклюзионная проекция верхнего зубного ряда: до (a) и после (b) нано-остеоперфорации.



Fig. 14. Occlusal projection of the lower dental arch before (a) and after (b) nano-osteoperforations.

Рис. 14. Оклюзионная проекция нижнего зубного ряда до (a) и после (b) нано-остеоперфорации.

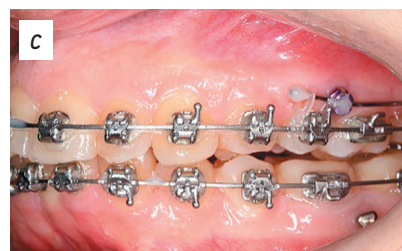


Fig. 15. Dental arches, right lateral projection (a), posteroanterior projection (b), left lateral projection (c).

Рис. 15. Зубные ряды: боковая правая проекция (a), прямая проекция (b), боковая левая проекция (c).

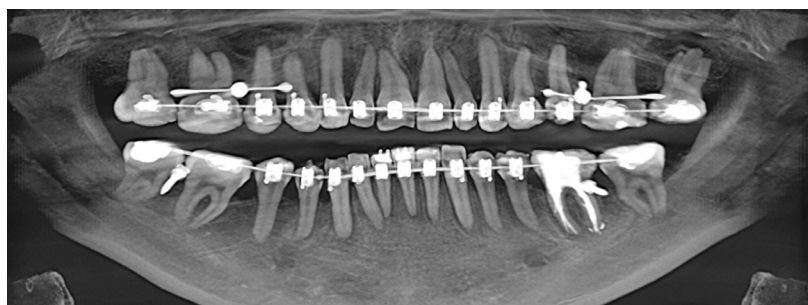


Fig. 16. Section of computed tomography of jaws after nano-osteoperforations.

Рис. 16. Срез компьютерной томограммы челюстей после нано-остеоперфораций.

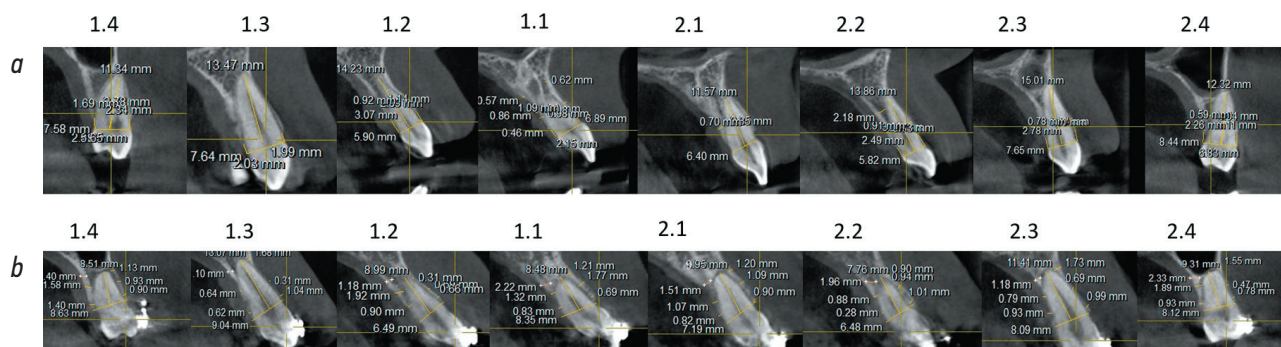


Fig. 17. Sections of computed tomography of the jaws before (a) and after (b) nano-osteoperforations, in the teeth area 1.4–2.4.

Рис. 17. Срезы компьютерной томограммы челюстей до (a) и после (b) нано-остеоперфораций, в области зубов 1.4–2.4.

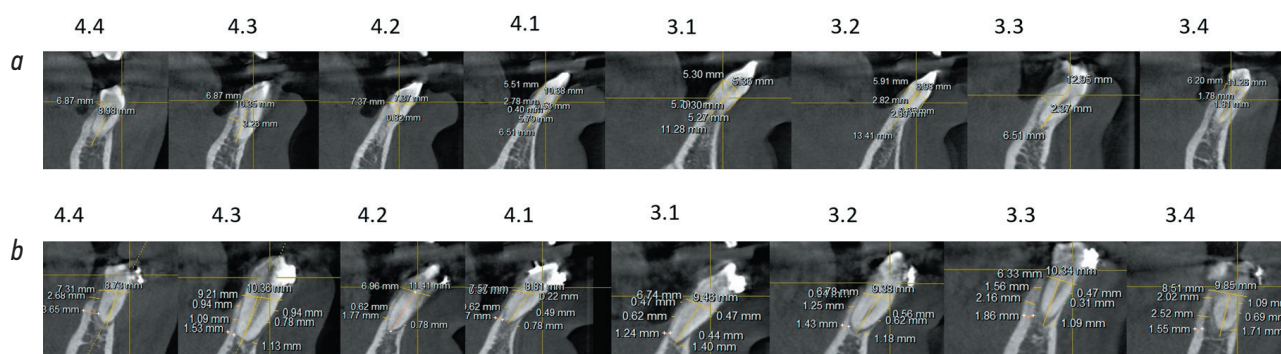


Fig. 18. Sections of computed tomography of the jaws before (a) and after (b) nano-osteoperforations, in the 4.4–3.4 teeth region.

Рис. 18. Срезы компьютерной томограммы челюстей до (a) после (b) нано-остеоперфораций, в области зубов 4.4–3.4.

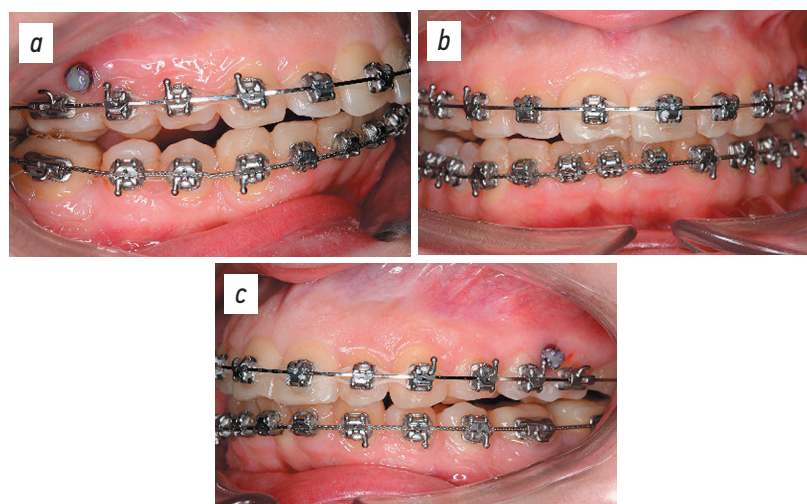


Fig. 19. Dental arches: lateral right projection (a), posteroanterior projection (b), lateral left projection (c).

Рис. 19. Зубные ряды: боковая правая проекция (a), передняя проекция (b), боковая левая проекция (c).

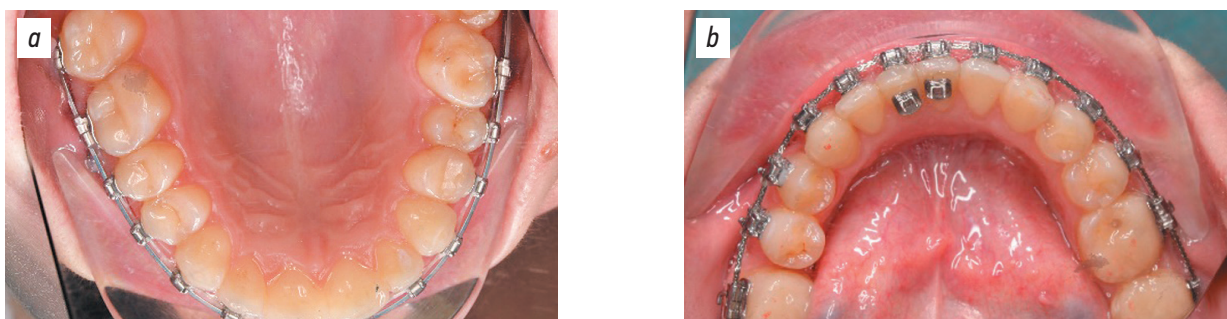


Fig. 20. Occlusal projection of the upper dental arch (a) and the lower dental arch (b).

Рис. 20. Оклюзионная проекция верхнего зубного ряда (a), нижнего зубного ряда (b).

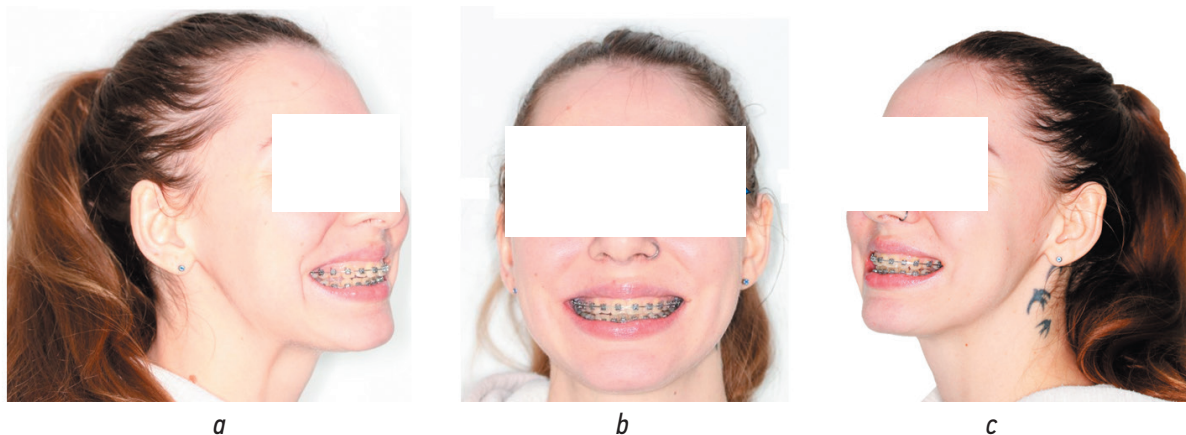


Fig. 21. Photo of the patient's face during the treatment: right three-quarter view with a smile (a), frontal view with a smile (b), left three-quarter view with a smile (c).

Рис. 21. Фотография лица пациентки на этапе лечения: $\frac{3}{4}$ оборота с улыбкой справа (a), с улыбкой анфас (b), $\frac{3}{4}$ оборота с улыбкой слева (c).

The thickness of the bone surrounding each tooth was measured before and after nano-osteoperforation (Figs. 17, 18).

In the majority of cases, the thickness of the cortical plate was lower than that of the trabecular bone. Nano-osteoperforations typically result in a decrease in both cortical and trabecular bone thickness, reducing the duration of orthodontic treatment. Bone thickness variations between teeth indicate heterogeneity of the surrounding bone tissue structure.

The outcomes of orthodontic treatment are presented in Figs. 19–21.

This clinical case demonstrated a 2-fold reduction in treatment duration compared to conventional approaches.

CONCLUSION

Nano-osteoperforations promote more rapid arch expansion and improve the positioning of lower incisors. This minimally invasive technique optimizes orthodontic treatment and reduces pain in patients with maxillary and mandibular arch constriction and incisor crowding.

ADDITIONAL INFO

Authors' contribution. Thereby, all authors confirm that their authorship complies with the international ICMJE criteria (all authors have made a significant contribution to the development of the concept, research, and

preparation of the article, as well as read and approved the final version before its publication). Personal contribution of the authors: R.A. Fadeev, planning practical work; T.A. Shchedrina, doing the bulk of the work, analyzing and formatting the results.

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Competing interests. The authors declare the absence of obvious and potential conflicts of interest related to the publication of this article.

Consent for publication. The authors received the written informed voluntary consent of the patient to publish his photographs (with his face covered) in a scientific journal, including its electronic version.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Вклад авторов. Все авторы внесли существенный вклад в проведение исследования и подготовку статьи, прочли и одобрили финальную версию перед публикацией. Вклад каждого автора: Р.А. Фадеев — планирование практической работы; Т.А. Щедрина — выполнение основного объема работы, анализ и оформление результатов.

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при написании статьи.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Согласие на публикацию. Авторы получили письменное информированное добровольное согласие пациента на публикацию его фотографий (с закрытием лица), в научном журнале, включая его электронную версию.

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