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Bone sampling method using angular surgical tip with retractor protector

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Abstract

INTRODUCTION. Today, pronounced atrophic changes in the alveolar jaws processes are often diagnosed, requiring bone tissue expansion using autogenic bone tissues of the patient, where various medical instruments and methods are used. Meanwhile, the problems of their improvement, minimizing the trauma of interventions, increasing regenerative processes and clinical effectiveness, have not been fully resolved. Thus, our research related to the optimization of medical instruments and methods remains relevant.

AIM is optimization of bone augmentation in patients using the developed method of bone tissue sampling using an angular surgical tip with a protector-retractor with severe atrophy of the alveolar processes in preparation for dental implantation.

MATERIALS AND METHODS**.** We used the developed device and method for creating cortical bone cuts during bone autograft sampling in bone plastic using an angular surgical tip with a retractor protector (patent No. 233201 dated 11.04.2025, published by 11.04.2025 Buhl. No. 11; Patent Application 2025120686, W25048732, issued 27.07.2025). The research was carried out at the surgical department of the dental clinic of North-Eastern Federal University and dental clinic “Avandent” (Yakutsk). Inclusion criteria in the research were associated with the presence of partial secondary adentia with marked alveolar atrophy. Exclusion criteria: generalized pathologies of decompensated form, malignant neoplasms, diseases of the hematopoietic system and intolerance to local anesthetics. Each patient gave his written consent for interventions. There were 2 groups: the main group – 105 patients, aged 42–68 years old; control group – 33, aged 40-69 years old using a protective device made of D.M. Mukhamadiev’s plastic (patent RU 213 284 U1, A61S 1/16 of 05.09.2022). Statistical processing of the material was carried out according to standard methods.

RESULTS. The results characterized low-trauma, safety and efficiency of surgical interventions, and design features of developed protector-retractor with metal body and shortened irrigation tube for angular surgical tip provide tight fixation, as well as minimal delamination of mucoperiosteal flap, reusability of practical application and convenience of pre-sterilization cleaning. Whereas, the plastic tread does not have these advantages due to the design features and material of manufacture.

CONCLUSIONS. The developed method provides certain advantages associated with the presence of a thin metal protector-retractor body for the angular surgical tip, which provides the best view of the surgical field, increases the safety and effectiveness of surgical interventions.

Keywords: dental implantation, pronounced atrophy of the alveolar process, bone augmentation, bone autograft, retractor-protector of soft tissues, surgical angular tip.

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Способ забора костной ткани с использованием углового хирургического наконечника с протектором-ретрактором

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Резюме

ВВЕДЕНИЕ. На сегодняшний день нередко выявляются выраженные атрофические изменения альвеолярных отростков челюстей, требующие проведения наращивания костной ткани с применением аутогенных костных тканей пациента, где используются различные медицинские инструменты и способы. Тем временем до конца не решены проблемы их совершенствования, направленные на минимизирование травматичности вмешательств, повышения регенеративных процессов и клинической эффективности. В связи с этим исследования, связанные с оптимизацией медицинского инструментария и способов их применения в стоматологии остаются актуальными.

ЦЕЛЬ ИССЛЕДОВАНИЯ. Оптимизация аугментации костной ткани пациентам с применением разработанного метода забора костной ткани с использованием углового хирургического наконечника с протектором-ретрактором при выраженных атрофиях альвеолярных отростков на этапе подготовки к дентальной имплантации.

МАТЕРИАЛЫ И МЕТОДЫ. Применялись разработанные устройство и способ создания пропилов кортикальной кости при заборе костного аутотрансплантата при костной пластике с использованием углового хирургического наконечника с протектором-ретрактором (патент № 233201 от 11.04.2025, опубликован 11.04.2025 Бюл. № 11; заявка на патент № 2025120686, входящий № W25048732 от 27.07.2025). Исследования проводились в хирургическом отделении стоматологической поликлиники Северо-Восточного федерального университета имени М.К. Аммосова» и студии современной стоматологии «Авандент» (Якутск). Критерии включения в исследованиях были связаны с наличием частичной вторичной адентии с выраженной атрофией альвеолярного отростка. Критерии невключения: общесоматические патологии декомпенсированной формы, злокачественные новообразования, заболевания органов кроветворной системы и непереносимость местных анестетиков. У каждого пациента были получены письменные согласия на проведение вмешательств. Сформированы две группы: основная группа – 105 пациентов в возрасте 42–68 лет; контрольная группа – 33 в возрасте 40–69 лет с применением защитного устройства из пластика Д.М. Мухамадиева (патент RU 213 284 U1, A61C 1/16 от 05.09.2022). Статистическая обработка материала проводилась по стандартным методам.

РЕЗУЛЬТАТЫ. Полученные результаты характеризуют малотравматичность, безопасность и повышение эффективности выполнения оперативных вмешательств, а конструктивные особенности разработанного протектора-ретрактора с металлическим корпусом и укороченной ирригационной трубкой для углового хирургического наконечника обуславливают плотную фиксацию, а также минимальное отслаивание слизисто-надкостничного лоскута, многоразовость практического применения и удобство предстерилизационной очистке. Тогда как, пластмассовый протектор за счет конструктивных особенностей и материала изготовления данных преимуществ не имеет.

ВЫВОДЫ. Разработанный способ обуславливает наличие определенных преимуществ, которые связаны с наличием тонкого металлического корпуса протектора-ретрактора для углового хирургического наконечника, обеспечивающий наилучший обзор операционного поля, повышает безопасность и эффективность проводимых хирургических вмешательств.

Ключевые слова: дентальная имплантация, выраженная атрофия альвеолярного отростка, аугментация костной ткани, костный аутотрансплантат, ретрактор-протектор мягких тканей, хирургический угловой наконечник.

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INTRODUCTION

At present, the high prevalence of dental diseases among the population determines the frequency of dentition defects, which often necessitate comprehensive rehabilitation involving the use of intraosseous titanium implants [1; 2]. In many cases, pronounced atrophic changes of the alveolar processes of the jaws are observed, requiring bone augmentation procedures utilizing the patient's autogenous bone tissue, with the application of various surgical instruments and techniques [3–5]. However, the challenges of improving these approaches remain unresolved, particularly in terms of reducing surgical invasiveness, enhancing regenerative processes, and increasing clinical effectiveness [6–8]. In this context, research aimed at optimizing surgical instrumentation and methods of their application in dental implantation remains highly relevant.

AIM

Optimization of bone augmentation in patients using a newly developed bone harvesting technique with an angled surgical handpiece equipped with a protector–retractor in cases of severe alveolar ridge atrophy during the preparatory stage of dental implantation.

MATERIALS AND METHODS

In the course of the research work aimed at preparation for dental implantation, corticotomy of the mandible was performed using the newly developed device and technique for cortical bone sectioning during autogenous bone harvesting. The procedure involved an angled surgical handpiece equipped with a diamond disk bur and a protector–retractor (Patent No. 233201, issued on 11.04.2025, published in Bulletin No. 11, 11.04.2025; patent application No. 2025120686, filing No. W25048732 dated 27.07.2025).

To evaluate the effectiveness of the proposed method, two groups were formed: the main group – 105 patients aged 42–68 years; and the control group – 33 patients aged 40–69 years, in whom the protective device made of plastic by D.M. Mukhamadiev was used (Patent RU 213 284 U1, A61C 1/16, issued 05.09.2022).

The study was conducted at the Surgical Department of the Dental Clinic, North-Eastern Federal University named after M.K. Ammosov, and at the Avandent Studio of Modern Dentistry (Yakutsk). Under local anesthesia, surgical interventions were carried out in patients with severe alveolar ridge atrophy to increase bone volume as part of pre-implantation preparation.

For this purpose, a newly developed soft-tissue protector–retractor for the angled surgical handpiece was employed (Fig. 1). Figure 2 illustrates the protector–retractor for the angled surgical handpiece in assembled working configuration.

The protective device was manufactured from medical-grade stainless steel (GOST 12x18N10) and sterilized in the same manner as other reusable medical instruments.

The inclusion criteria in this study were defined as the presence of partial secondary edentulism with pronounced alveolar ridge atrophy. The exclusion criteria comprised decompensated systemic pathologies, malignant neoplasms, hematopoietic disorders, and intolerance to local anesthetics. Written informed consent for the surgical interventions was obtained from all patients.

The research data were processed using the statistical software package *Statistica 6.0* (StatSoft, USA). The significance of differences between the studied parameters was determined using p-values, with values equal to or less than 0.05 considered statistically significant ($p \leqslant 0.05$).

RESULTS

The technique utilizing an angled surgical handpiece with a diamond disk bur and the newly developed soft-tissue protector–retractor was applied for harvesting autogenous bone grafts from the mandibular angle. The primary aim of this method is the use of a simple, cost-effective, and reusable protective device compatible with the angled surgical handpiece, thereby enhancing the safety and efficiency of surgical interventions while ensuring minimal invasiveness.

The procedure was performed as follows. After conduction and infiltration anesthesia with *Ultracaine forte 4%* (4.5 mL with epinephrine 1:100,000), incisions were made using a No. 15C scalpel, and a trapezoidal full-thickness flap was elevated with a periosteal elevator to provide access to the external oblique ridge. At a speed of 35,000 rpm, with the use of an *NSK Surgik Pro*+ physiodispenser and a carbide bur mounted on a straight handpiece under copious irrigation with chilled saline solution, perforation holes were created in the cortical bone of the anterior surface of the external oblique ridge over a length of 20 mm at a distance of 3–4 mm from the lateral surface.

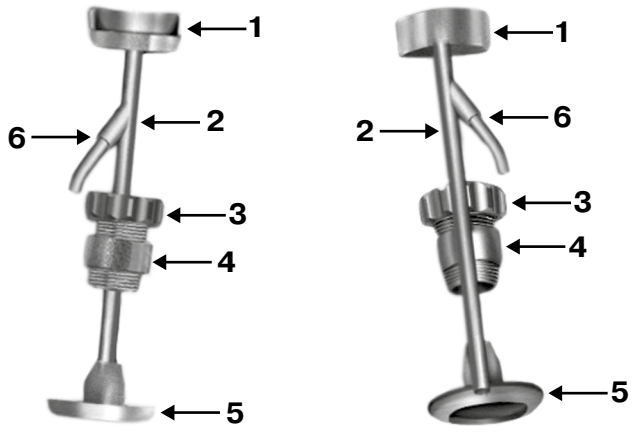

Fig. 1. Soft-tissue protector–retractor for the angled surgical handpiece: *A* – anterior view, *B* – posterior view, *1* – a terminal half-ring with a support platform for accommodating the diamond disk bur, *2* – a metallic body with ergonomic curves, *3* – a head-fixing screw, *4* – a screw holder with internal threading; *5* – a support ring for the surgical handpiece head, *6* – a built-in shortened irrigation tube integrated into the body for cooling the diamond disk bur

Рис. 1. Протектор-ретрактор мягких тканей для хирургического углового наконечника: *A* – вид спереди, *B* – вид сзади; *1* – торцевое полукольцо с упорной площадкой для размещения в нем дисковой алмазной фрезы, *2* – корпус из металлического основания с эргономичными изгибами, *3* – винт-фиксатор головки наконечника, *4* – держатель винта с внутренней резьбой, *5* – кольцо для упора головки хирургического наконечника, *6* – встроенная в корпус укороченная ирригационная трубка для охлаждения дисковой фрезы

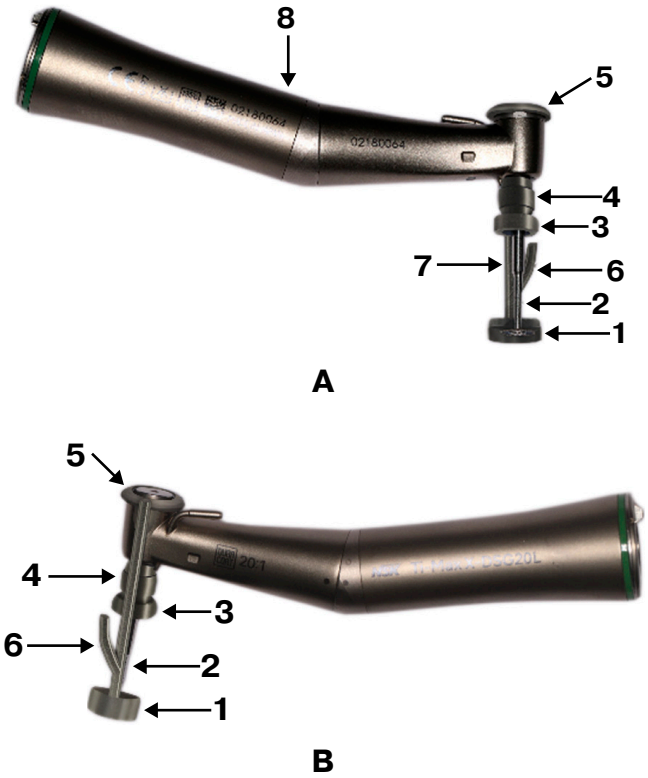

Fig. 2. Soft-tissue protector–retractor for the angled surgical handpiece in the assembled working configuration: *A* – right view, *B* – left view, *7* – the diamond disk bur, *8* – the NSK angled handpiece “Ti-Max X-SG20L”

Рис. 2. Протектор-ретрактор мягких тканей для хирургического углового наконечника в собранном рабочем виде: *A* – вид справа, *B* – вид слева, *7* – дисковая алмазная фреза, *8* – угловой наконечник NSK «Ti-Max X-SG20L»

Subsequently, vertical distal and mesial bone cuts, 10 mm in height and 3 mm in depth, were made in the mandibular ramus area with a straight handpiece (Fig. 3). This was followed by a horizontal apical osteotomy, 20 mm in length and 3 mm in thickness, performed with the angled surgical handpiece equipped with the diamond disk bur and the developed soft-tissue protector–retractor (Fig. 4) at a speed of 2,000–3,000 rpm under copious saline irrigation, connecting the mesial and distal cuts (Fig. 5).

The bone osteotomies of the mandibular ramus were then inspected to confirm the absence of trauma to surrounding soft tissues, which was achieved due to the ergonomic terminal half-ring of the device. Minimally invasive surgical access was ensured by additional effective retraction of adjacent tissues, thus reducing the extent of mucoperiosteal flap elevation. The cortical perforation sites on the anterior surface of the external oblique ridge were then connected using a Lindemann bur on a straight handpiece. With a single gentle mallet strike applied to a chisel, a cortical bone block measuring 20 × 10 × 3.5 mm was harvested (Fig. 6).

The bone block was placed in a titanium cup with sterile saline solution (Fig. 7). The donor site was cleared of all visible mobile bone fragments, irrigated with 20 mL of 0.05% chlorhexidine solution, and sutured with interrupted *Monocryl 5-0* stitches. The harvested cortical bone block was subsequently used for alveolar ridge augmentation at the site of pronounced atrophy, following the standard clinical protocol.

Fig. 3. Vertical osteotomy of the left mandibular ramus using the soft-tissue protector–retractor for the surgical straight handpiece

Рис. 3. Вертикальная остеотомия ветви нижней челюсти слева с применением ретрактора-протектора мягких тканей для хирургического прямого наконечника

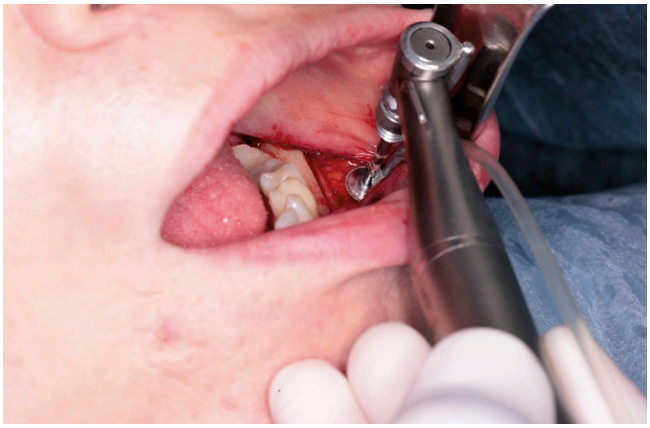

Fig. 5. Horizontal osteotomy of the left mandibular ramus using the soft-tissue protector–retractor for the angled surgical handpiece

Рис. 5. Горизонтальная остеотомия ветви нижней челюсти слева с применением ретрактора-протектора мягких тканей для хирургического углового наконечника

Fig. 4. Soft-tissue protector–retractor for the angled surgical handpiece in assembled working configuration with an irrigation tube

Рис. 4. Ретрактор-протектор мягких тканей для хирургического углового наконечника в собранном рабочем виде с ирригационной трубкой

Fig. 6. Harvested cortical bone block from the left mandibular ramus using the soft-tissue protector–retractor for the angled surgical handpiece

Рис. 6. Сформированный костный блок с ветви нижней челюсти слева с применением ретрактора-протектора мягких тканей для хирургического углового наконечника

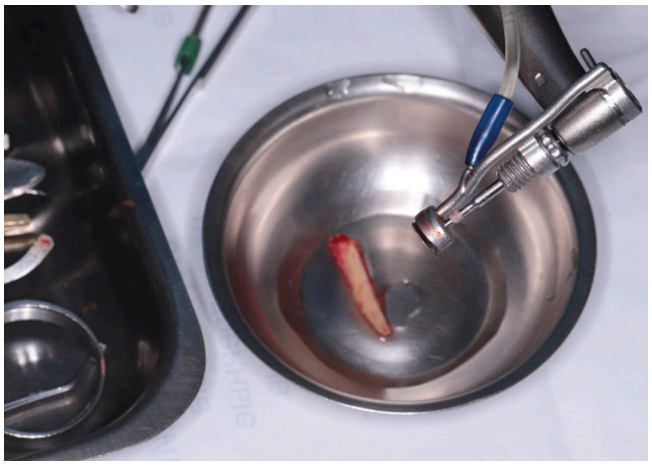

Fig. 7. Prepared cortical bone block harvested from the left mandibular ramus for autotransplantation

Рис. 7. Выделенный из ветви нижней челюсти слева готовый костный блок для аутотрансплантации

Overall, based on the results obtained from corticotomy during harvesting of a mandibular ramus bone block using the angled surgical handpiece with a diamond disk bur and the developed soft-tissue protector–retractor, the proposed method demonstrates the following advantages compared to existing solutions:

– corticotomy performed with the device made of medical-grade stainless steel ensures secure fixation on the angled surgical handpiece;

– the firm attachment of the device to the handpiece allows it to function as an additional soft-tissue retractor, minimizing mucoperiosteal flap elevation in the surgical area;

– the material of the protector–retractor permits sterilization using standard methods and allows for multiple practical uses;

– the protector–retractor is equipped with a shortened irrigation tube, facilitating pre-sterilization cleaning of its lumen and subsequent sterilization;

– the versatility of the soft-tissue protector–retractor enables bone cuts in the mandibular ramus region on both the right and left sides;

– the ergonomic and compact design of the protector–retractor provides excellent visualization of the surgical field;

– the technique ensures minimally invasive intervention while enhancing postoperative tissue regenerative processes;

– the anti-glare effect of the protector–retractor has practical significance during procedures performed with an operating microscope and/or individualized binocular loupes.

Furthermore, the use of the device during corticotomy for harvesting a mandibular ramus bone block with the angled surgical handpiece equipped with a diamond disk bur and soft-tissue protector–retractor contributes to increased efficiency and safety of surgical interventions for bone augmentation in cases of pronounced alveolar ridge atrophy prior to dental implantation.

Clinical case example

Patient A., born in 1975, presented to the Dental Clinic of the North-Eastern Federal University named after M.K. Ammosov on 15.01.2025 with complaints of partial absence of the posterior teeth in the right maxilla. Clinically, intraoral examination revealed partial secondary edentulism in the region of teeth 1.5, 1.6, and 1.7, corresponding to Kennedy Class II. The mucosa of the alveolar ridge on both the vestibular and oral sides was pale pink, with lateral alveolar ridge atrophy observed. Cone-beam computed tomography demonstrated an alveolar bone height of 8–10 mm in the region of teeth 1.5–1.7 up to the floor of the maxillary sinus, with vertical alveolar ridge atrophy of 1.7–2.1 mm at the crest.

Following consultation with a prosthodontist and implant surgeon, and after comprehensive clinical and laboratory examination, it was decided to perform lateral alveolar ridge augmentation using an autogenous bone block harvested from the left mandibular ramus.

On 21.01.2025, bone augmentation was performed in the right maxilla according to the Kuri method, with harvesting of an autogenous bone block from the left mandibular ramus.

Surgical procedure: Under local infiltration anesthesia with 5.5 mL of 4% *Ultracaine Forte* (1:100,000 epinephrine), incisions were made along the alveolar ridge using a scalpel, and a trapezoidal vestibular full-thickness mucoperiosteal flap was elevated with a periosteal elevator to provide access to the external oblique ridge on the left side for bone block harvesting.

Using an *NSK Surgic Pro+* physiodispenser on a straight handpiece at 35,000 rpm, with a carbide bur and copious irrigation with chilled saline, linear perforation holes were created in the cortical bone of the anterior surface of the left external oblique ridge, 20 mm in length and positioned 4 mm from the lateral surface.

Subsequently, the angled surgical handpiece with the soft-tissue protector–retractor (NSK “Ti-Max X-SG20L”) was assembled, and a 6-mm diamond disk bur was attached. The handpiece with the protective device was adapted to the recipient site. At a speed of 2,000 rpm, a horizontal apical osteotomy, 20 mm in length and 3 mm in thickness, was performed under copious irrigation.

Two vertical bone cuts were then made using a straight surgical handpiece with a disk bur – distal and mesial – 10 mm in height and 3 mm in thickness, connecting the horizontal cut. The bone cuts were inspected to confirm the absence of trauma to surrounding soft tissues.

Using a Lindemann bur on a straight handpiece, the perforation holes in the cortical bone of the anterior surface of the external oblique ridge were connected. With a single gentle mallet strike applied to a chisel, a cortical bone block measuring 20×10×3.5 mm was harvested. The bone block was placed in a titanium cup with chilled saline solution. The donor site was cleared of all visible mobile bone fragments and irrigated with 20 mL of 0.05% chlorhexidine solution. The lingual flap was mobilized bluntly.

Autogenous bone chips were obtained by thinning the cortical block using a sterile disposable bone scraper (*Safescraper Twist*, Italy). The bone block was then fixed

to the recipient site using three titanium screws (d 1.2 mm, 10 mm in length). The space between the bone block and the alveolar ridge was densely filled with the harvested autogenous bone chips. The wound was closed using mattress and interrupted *Monocryl 5-0* sutures.

On 25.01.2025, the patient presented for postoperative examination. Clinically, the general condition was satisfactory; facial configuration was altered due to postoperative edema of the right buccal and infraorbital regions; regional lymph nodes were not palpable; full, painless mouth opening; oral mucosa without pathological changes; palpation of the operative site was painless, with no discharge and no signs of infection; sutures were intact.

On 30.01.2025, the patient returned for suture removal. Clinically, the general condition was satisfactory; facial configuration was unchanged; regional lymph nodes were not palpable; mouth opening was free and painless; oral mucosa at the left mandibular donor site showed no pathological changes; palpation of the postoperative site was painless, with no discharge and no signs of infection. Sutures were removed.

Overall, the straight surgical handpiece with the protector–retractor was successfully adapted for harvesting a mandibular ramus bone block. Clinical evaluation confirmed the effectiveness and safety of the device, as well as the convenience and ergonomics of the protector–retractor, good visualization of the surgical field, and optimal irrigation delivery to the disk bur.

In contrast, the practical use of the previously described plastic protective device revealed several shortcomings: due to the flexibility of the plastic, the bur may contact the terminal half-ring in hard-to-reach areas, and the device does not attach securely to the angled surgical handpiece. The wide base of the plastic device partially obstructs the surgical field. Furthermore, this device is intended for single use only, as it cannot withstand high-temperature sterilization.

Comparative clinical analysis demonstrated that in the study group, hematoma formation in the operative field occurred 1.71 times less frequently, and regression of postoperative inflammatory edema began on day 3 ($p \leqslant 0.05$), compared to day 4 in the control group ($p \leqslant 0.05$). Sutures were removed on days 7–10 in the study group and on days 10–14 in the control group ($p \leqslant 0.05$).

DISCUSSION

Currently, various techniques are employed for bone tissue augmentation. One such method involves corticotomy with simultaneous guided bone regeneration in the anterior mandible during orthodontic treatment of patients with occlusal anomalies (Patent No. RU (11) 2 826 752(13) C1, 20.03.2024). This method includes a curved incision of the oral mucosa under infiltration anesthesia, with a 5.0 mm offset at the level of teeth 31 and 41 and a 7.0 mm offset at the level of teeth 32 and 42 from the boundary between attached and movable mucosa. The mentalis muscle is incised at a 45° angle down to the periosteum. The periosteum is then incised and elevated apically, exposing the alveolar portion of the mandible between teeth 34–44 and the chin area. Autogenous bone chips are harvested from the mandibular symphysis using a bone scraper. Corticotomy is performed between the roots of teeth 44, 43, 42, 41, 31, 32, 33, and 34 using a piezotome to a depth reaching the cortical layer down to the cancellous bone, leaving 1 mm short of the alveolar crest coronally and 1 mm below the root apex apically. The harvested autogenous bone chips are mixed with an allogeneic graft in a 1:1 ratio, and the resulting bone mixture is placed on the alveolar ridge surface in the corticotomy area with a layer thickness of at least 5 mm. A fibrin membrane is applied over the graft, and the apically repositioned periosteum is secured coronally with resorbable sutures. The muscles and mucosa are then closed.

The limitations of this technique include extensive exposure of the corticotomy area, wide ultrasonic cortical bone cuts with associated invasiveness to surrounding tissues, difficulty in achieving long straight cuts, and insufficiently controlled visualization of the osteotomy site during surgery on both the maxilla and mandible.

A method proposed by F. Khory [9, pp. 115–124] involves harvesting a bone block from adjacent areas of the mandible (chin, mandibular ramus). The procedure includes performing a trapezoidal incision in the area of the alveolar ridge defect, a linear incision in the region of the external oblique ridge or chin, and harvesting the autotransplant using a straight handpiece protector (*Frios MicroSaw*, Dentsply Sirona, Germany). The harvested block is longitudinally split into two plates. One plate is fixed with screws to the outer surface of the alveolar ridge, and bone chips obtained by milling part of the autogenous block are placed in the defect area. In cases of vertical or combined atrophy, the second plate is fixed on top with a screw, and the wound is closed. After 3–4 months, dental implants are placed, followed by prosthetic rehabilitation.

The limitations of this method include the long irrigation tube of the known straight-handpiece protector, which has multiple bends, complicating pre-sterilization cleaning and sterilization of the instrument. Additionally, the thick surgical handpiece increases the invasiveness of the procedure.

CONCLUSION

The application of the developed method for harvesting bone tissue using an angled surgical handpiece with a protector–retractor ensures a minimally invasive approach for cortical bone osteotomies during bone block harvesting. This contributes to increased safety and effectiveness of treatment aimed at augmenting bone volume prior to dental implant placement, owing to the positive structural features of the device. The shortened external irrigation tube enables efficient cooling of the disk bur while facilitating pre-sterilization cleaning of the lumen for subsequent sterilization.

The developed method can also be successfully applied for harvesting autogenous bone from other regions of the facial skeleton, for creating lateral windows to access the maxillary sinus, and for alveolar ridge reduction of the mandible and maxilla prior to dental implant placement.

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Onik S. Unusyan – collection of clinical material, design of illustrative material.

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