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Device for manual unstressed osteotome mucotome for taking three-layer autograft from maxillary tubercle

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Abstract

INTRODUCTION. Recently, the direction of dentition defects restoration on artificial supports with immediate dentoalveolar reconstruction of the alveolar process which is widely used for the bone crest and soft tissues loss develops rapidly. The main factors in the formation of destructive changes in the alveolar process are chronic foci of infection in the periapical region, localized and generalized pathologies of periodontal tissues, fractures of the bones of the facial skeleton and teeth, as well as non-carious lesions of the roots of the teeth (internal and external resorption). In this regard, when performing dental implantation, it is necessary to pay attention to the implementation of additional interventions restoring the anatomical shape of the alveolar process using various tools, materials and methods. Taking into account the above, a manual unstressed mucotome-osteotome device was developed for taking a three-layer autograft from the tubercle of the upper jaw, and the results of its practical use are presented in this research.

AIM. Purpose of the research is to improve the efficiency of surgical and orthopedic stages of dental defect repair in dental implantation with dentoalveolar reconstruction by developing a special device.

MATERIALS AND METHODS. The paper presents the results of our practical application of the manual unstressed mucotome-osteotome for taking a triplraft from the retromolar region of the upper jaw (tubercle) (patent application No. 2025131706 dated 14.11.2025). At the same time, a dynamic analysis of the effectiveness of our developed device for three years was carried out in 112 clinical cases in the age group from 21 to 69 years old. Statistical evaluation of the obtained results was carried out in the MS Office Excel program using standard methods.

RESULTS. The combination of the main features of the developed device and its use contribute to improving the quality of graft preparation by extracting a single three-layer graft consisting of mucosal connective tissue with periosteum, cortical and spongy bone tissue from the tubercle of the upper jaw, which determine the clinical effectiveness of its use in osteoplastic operations and simultaneous dental implantation.

CONCLUSIONS. The obtained clinical results of practical application of the developed manual unstressed mucotome-osteotome for sampling a three-layer autograft from the maxillary tubercle characterise its effectiveness, safety and ease of use of the given medical device.

Keywords: dental implantation, alveolar defect, maxillary tubercle, manual unstressed mucotome-osteotome device, three-layer autograft, immediate dentoalveolar reconstruction

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Устройство для ручного безнатяжного остеотомно-мукотомного забора трехслойного аутотрансплантата из бугра верхней челюсти

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Резюме

ВВЕДЕНИЕ. В последнее время активно развивается направление восстановления дефектов зубных рядов на искусственных опорах с одномоментной дентоальвеолярной реконструкцией альвеолярного отростка, что широко применяется при утрате костного гребня и мягких тканей. Основными факторами формирования деструктивных изменений альвеолярного отростка являются хронические очаги инфекции в периапикальной области, локализованные и генерализованные заболевания тканей па-

родонта, переломы костей лицевого скелета и зубов, а также некариозные поражения корней зубов (внутренняя и внешняя резорбция). В этой связи при проведении дентальной имплантации необходимо уделять внимание выполнению дополнительных вмешательств, направленных на восстановление анатомической формы альвеолярного отростка с использованием различных инструментов, материалов и методов. С учетом вышеизложенного было разработано устройство – ручной безнатяжной мукотом-остеотом для забора трехслойного аутотрансплантата из бугра верхней челюсти, и представлены результаты его практического применения.

ЦЕЛЬ. Повышение эффективности хирургического и ортопедического этапов лечения дефектов зубных рядов при дентальной имплантации с дентоальвеолярной реконструкцией путем разработки специального устройства.

МАТЕРИАЛЫ И МЕТОДЫ. В работе представлены результаты практического применения разработанного нами ручного безнатяжного мукотома-остеотома для забора трехслойного трансплантата из ретромолярной области верхней челюсти (бугра) (заявка на патент № 2025131706 от 14.11.2025). Проведен динамический анализ эффективности устройства в течение трех лет на основании 112 клинических случаев в возрастной группе от 21 до 69 лет. Статистическая обработка полученных данных выполнена в программе MS Office Excel с использованием стандартных методов.

РЕЗУЛЬТАТЫ. Совокупность конструктивных особенностей разработанного устройства и методики его применения способствует повышению качества забора трансплантата за счет извлечения единого трехслойного блока, включающего слизисто-соединительнотканный компонент с надкостницей, кортикальную и губчатую костную ткань из бугра верхней челюсти, что определяет клиническую эффективность его использования при остеопластических операциях и одномоментной дентальной имплантации.

ВЫВОДЫ. Полученные клинические результаты практического применения разработанного ручного безнатяжного мукотома-остеотома для забора трехслойного аутотрансплантата из бугра верхней челюсти свидетельствуют о его эффективности, безопасности и удобстве использования данного медицинского изделия.

Ключевые слова: дентальная имплантация, альвеолярный дефект, бугор верхней челюсти, ручной безнатяжной мукотом-остеотом, трехслойный аутотрансплантат, одномоментная дентоальвеолярная реконструкция

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INTRODUCTION

Recently, the direction of restoration of dentition defects on artificial supports with immediate dentoalveolar reconstruction of the alveolar process, which is widely used for bone crest and soft tissue losses, is developing rapidly [1]. Despite the extensive study of major dental diseases, their prevalence and intensity do not tend to decrease, which remain the main factors in the formation of destructive changes in the alveolar process associated with chronic foci of infection in the periapical region, localized and generalized pathologies of periodontal tissues, traumatic injuries to the bones of the facial skeleton and teeth, as well as non-carious lesions of the roots of teeth (internal and external resorption) [2].

It should be noted that in some clinical cases, the presence of a lack of vestibular bone tissue can lead to gum recession and a decrease in the height of the mucous membrane of the interdental papilla, which leads to a violation of the aesthetic profile of the patient's smile. To eliminate such shortcomings, various methods of soft and bone tissue augmentation are used, which have their positive and negative sides [3; 4]. At the same time, there is evidence that simultaneous dental implantation and immediate dentoalveolar reconstruction contribute to the launch of a number of biological metabolic processes stimulating bone repair, thereby allowing to preserve the initial bone volume and architectonics of soft tissue contours. This clinical approach leads to a pronounced reduction in the total rehabilitation time, a decrease in the number of repeated interventions and a decrease in the cost of treatment [5]. In this regard, during dental implantation, it is necessary to pay attention to additional interventions restoring the anatomical shape of the alveolar process using various tools, materials and methods [6]. With simultaneous implantation with immediate augmentation of extensive defects of the vestibular bone plate, the known methods may be ineffective when using bone substitutes (bone graft) and soft tissues (mucograft). In this regard, the "gold" standard of dental implantation in bone plasty is the use of autogenic tissues, where the use of tissues from the tubercle of the upper jaw is of particular importance [7; 8]. Taking into account the above, a manual unstressed mucotome-osteotome was developed for taking a three-layer autograft from the tubercle of the upper jaw and the results of its practical use are presented in this work.

AIM

Purpose of the research is to improve the efficiency of surgical and orthopedic stages of dental defect repair in dental implantation with dentoalveolar reconstruction by developing a special device.

MATERIALS AND METHODS

The paper presents the results of the practical application of our developed manual unstressed mucotome-osteotome for taking a triplraft from the retromolar region of the upper jaw (tubercle) (patent application No. 2025131706 dated 14.11.2025). At the same time, a dynamic analysis of the effectiveness of the developed device for three years was carried out in 112 clinical cases in the age group from 21 to 69 years old who visited the dental clinic of the North-Eastern Federal University and the surgical department of the dental clinic LLC Avandent (Yakutsk), regarding dental implantation in the front department maxilla. For comparative evaluation, a control group was formed, which included 34 patients aged 22–63 years old, where bone tissue was used from a tubercle without a soft tissue component, isolated by a standard method using a chisel and a hammer (patent No. 2733914 dated 02.12.2019). The inclusion criteria for the study group were consent, indications for removal of frontal teeth with simultaneous implantation, and satisfactory oral hygiene. Criteria for non-inclusion were refusal to participate in the study, active smokers (more than 10 cigarettes per day), concomitant pathology during the clinical study in the acute stage, severe general somatic diseases, intolerance to local anesthetics and the presence of cancer, as well as refusal to comply with the patient's recommendations. The main and control groups were formed by random sampling.

The proposed device is designed for less invasive, convenient, safe and efficient sampling of mucosal connective tissue with periosteum, cortical and spongy bone tissue from maxillary tubercle due to possibility to control force and speed of reciprocating (reciprocating) movements with hand using handle (Fig. 1). At the same time, a special arrangement of notches with a cutting effect (Fig. 2) during reciprocating movements ensures immersion of the milling cutter into the thickness of soft tissues and bone without violating their integrity, and the difference in thickness of the outer and inner surfaces of the cylindrical working part contributes to the easy movement of the extracted triplograph inside the trepan cylinder (Fig. 3). The use of the device during surgery helps to take a cylindrical bone graft and the required size from the tubercle of the upper jaw quickly. Application of claimed device provides obtaining three-layer autograft from tubercle of upper jaw without disturbance of morphological characteristics of tissues. Taking a triple autograft and reconstructing bone defects with immediate dental implantation is easy, fast and minimally invasive.

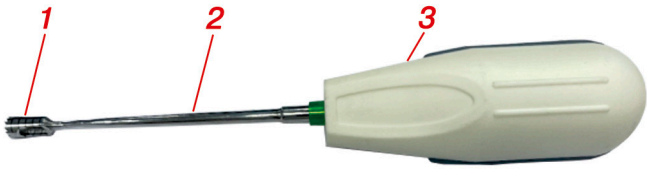
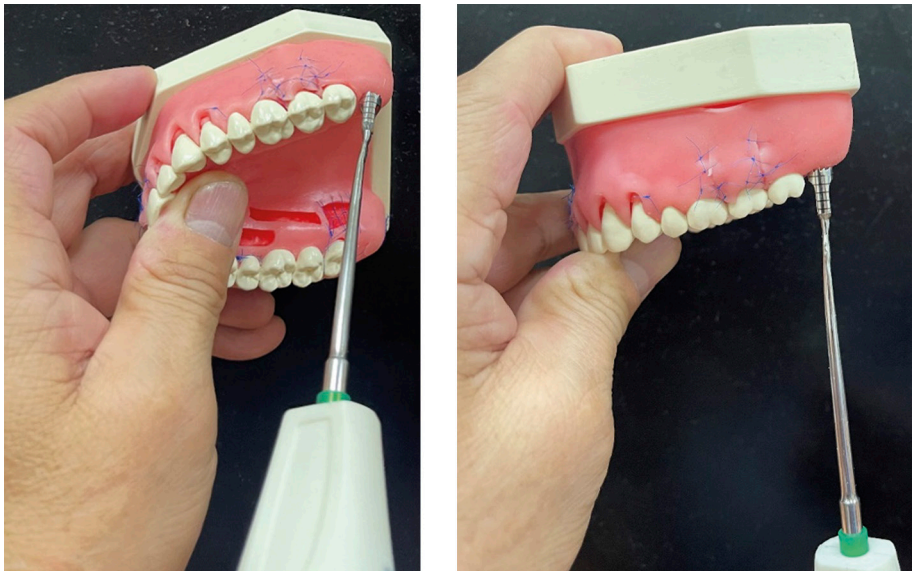


Fig. 1. Device for manual unstressed mucotome-osteotome for taking a three-layer autograft from the tubercle of the upper jaw:
1 – working part (trepan); *2* – rod; *3* – handle

Рис. 1. Устройство ручного безнатяжного мукотома-остеотома для взятия трехслойного аутотрансплантата из бугра верхней челюсти:
1 – рабочая часть (трепан); *2* – стержень; *3* – рукоятка

Fig. 2. Working part of device (trepan) with triangular cutting teeth

Рис. 2. Рабочая часть устройства (трепана) с треугольными режущими зубьями



A **B**

Fig. 3. Autologous three-layer autograft sampling (soft tissues, cortical and spongy bone) from the retromolar region of the upper jaw:
A – from below; *B* – from the side

Рис. 3. Выборка аутологичного трехслойного аутотрансплантата (мягкие ткани, кортикальная и губчатая кость) из ретромолярной области верхней челюсти: *A* – снизу; *B* – сбоку

The depth of trepan immersion is calculated on the results of a computer cone-ray tomogram obtained using the Pro apparatus and specialized software, where the height (to the bottom of the maxillary sinus) and the width of the alveolar process in the retromolar projection of the upper jaw are measured. The possible volume for taking a triple autograft was measured by virtual planning, placing in the retromolar region of the maxilla, where the virtual cylinder is equal to the trepan diameter of 6.0 mm and height, taking into account the exclusion of the probability of perforation of the Schneider membrane from the border with the maxillary sinus by 1.0 mm. After local anaesthesia with 4% Articaine, the device was placed with the cutting part on the mucous membrane in the region of the tubercle of the upper jaw at the site of the alleged intake of autogenous tissues. The trepan was immersed in a soft tissue complex, then a triple autograft was taken into the bone tissue of the retromolar region of the upper jaw to the required depth, while using the cutting teeth to reciprocate the trepan. Chips that are formed in the inner surface of the trepan are removed through an oval hole from two opposite sides, which reduces the application of forces when sawing bone tissue of the tubercle and, in general, the complexity of the process. Further, the device is easily removed by swinging the trepan in different directions. The taken cylinder-shaped tripleft remains in the inner surface of the trepan and is easily removed by pushing through the oval holes on the sides with tweezers. The produced triple autograph consisting of mucosal connective tissue with periosteum, cortical and spongy bone tissue from maxillary tubercle is used for replacement of defect in dental implantation, and soft tissues of donor site bring wound edges closer together, form blood clot and apply sutures.

A comparative assessment of the effectiveness of our device was carried out with the analysis of pain syndrome using a visual analog scale (VAS), where 0 is the absence of pain, then mild, moderate, severe and intolerable pain means 10 points. In addition, the severity of hyperemia of the mucous membrane of tissues in the donor area was assessed on the day of surgery, on the third day and after a week in the postoperative period according to the method of A.V. Vorobyeva, (2012). Monoquik 5.0 conditionally absorbable threads were used when suturing donor sites. In this case, the sutures were removed a week after the intervention.

The research was approved by the local ethics committee of the North-Eastern Federal University (protocol No. 40 dated 18.09.2022).

Statistical analysis of the research was carried out in the MS Office Excel program with an assessment of the reliability of differences at $p \leq 0.05$.

RESULTS

The assessment of clinical efficacy according to visual analogue scale data characterizes that in the patients of the main group, on day 1 after transplant sampling, the level of pain symptom in 52 (46.43±1.02%) patients was detected as mild pain, and in 21(18.75±1.51%) patients there was moderate pain, in 7 (6.25±1.74%) patients there was a strong pain symptom, while in 32 (28.57±1.33%) of patients noted that they did not experience pain. In the same group, on day 4, 23 (20.54±1.48%) patients had mild pain, and 89 (79.46±0.38%) had no pain syndrome at all. In the control group, on the 1 day after picking up the graft with a chisel, mild pain was detected in 6 patients (17.65±3.34%), moderate pain – 15 (44.12±2.29%), severe pain – 8 (23.53±3.13%), and very severe pain – 5 (14.70±3.50%), where there are no indicators of patients without a pain symptom. In the same group, on day 4, 16 patients (47.06±2.17%) had mild pain, moderate pain – 7 (20.59±3.25%), severe pain – 3 (8.83±3.74%), pain syndrome was completely absent in 8 (23.52±3.13%).

A comparative assessment of the severity of gum hyperemia in the donor zone characterizes the presence of certain features. So, in the patients of the main group, on the first day after surgery, hyperemia was interpreted as mild in 27 (24.10±1.40%), moderate in 73 (65.17±0.64%), bright in 12 (10.71±1.65%), there was no ischemia and cyanosis. On the third day, 63 (56.25±0.81%) patients had mucosal recovery to normal color, however, 3 (2.67±1.80%) patients had bright hyperemia, 28 (25.89±1.37%) – moderate and 18 (15.19±1.55%) – mild. On the seventh day, mild hyperemia was detected in 7 (6.25±1.73%) patients. Meanwhile, in the control group, on the first day after taking a bone graft from the tubercle of the upper jaw using a chisel and hammer, hyperemia was mild in 4 (11.77±3.64%), moderate in 23 (67.65±1.32%), and bright in 7 (20.58±3.20%). On the third day, in 3 (8.82±3.73%), the mucous membrane is characterized as pale pink, while in 5 (14.70±3.49%) hyperemia was detected, in 12 (35.50±2.63%) – moderate, in 14 (40.98±2.03%) – mild. On the seventh day, moderate hyperemia persisted in 6 (17.64±3.37%) patients.

The obtained results of the comparative evaluation of the proposed device use characterize clinical efficacy compared to the control group, which are associated with the fact that on day 4 in 79.46±0.38% ($p \leq 0.05$) the pain symptom completely disappears, while in the control group was 23.52±3.13%. In addition, on the seventh day, mild hyperemia was detected in 6.25±1.73% ($p \leq 0.05$) of patients in the main group, and in the control group – 40.98±2.03%.

The available design features of the device contribute to solving the problem by creating a low-traumatic device, which allows effective and, most importantly, safe sampling of a three-component autograft, consisting of connective tissue of the mucous membrane with periosteum, cortical and spongy bone tissue from the tubercle of the upper jaw with simultaneous dental implantation with pronounced bone and soft tissue defects of the alveolar process, standard implantation in case of alveolar process atrophy and removal of tooth socket. Reciprocating movements with the hand provide controlled effort and a complete three-layer autograft with a significant reduction in surgical time. Application of proposed device at sampling of three-layer autograft from tubercle of upper jaw makes it possible to extract combined soft-

tissue bone block of small diameter with preservation of surrounding bone tissue with imitation of removed tooth socket, which makes it possible to reduce edema and pain in postoperative period, providing predicted clinical effect. Arrangement of through oval grooves on opposite sides of mucotome-osteotome for sampling of three-layer autograft from upper jaw tubercle provides convenient extraction of transplant from trepan. In general, the stated advantages of the device create maximum efficiency, safety and ease of use of this medical device.

DISCUSSION

Nowadays, various devices are used to take an autograft from the tubercle of the upper jaw in dental implantation. Thus, a useful model of a cutter for obtaining a bone graft for dental implantation is known (patent No. 139356 from 20.04.2014), which consists of a cylindrical hollow body, as well as a knife having 1 or 2 blades. Local anaesthesia is followed by a scalpel incision followed by exfoliation of the mucoperiosteal flap, followed by fixing the bone mill into the surgical angular tip. Bone tissue is treated at revolutions within 10 to 100 rpm. Then dental implant and plug are installed into ready bone bed. Wound surface is sutured with application of aseptic bandage. The principal disadvantages of this useful model are the impossibility of obtaining a complete three-layer autogenous graft, which confirms its invasiveness.

In addition, in clinical dentistry, a device for taking bone grafts is used (patent No. 164582 from 10.09.2016) in the form of a cylinder with a cutter and cutting teeth at the end and the presence of a tail for fixation in a surgical tip. Note here that cylinder outer surface has two holes. After detachment of soft tissues, the device is placed with its working part on the bone, then the cutter is immersed in bone tissue to a certain depth. After that, the device is removed by rotating the drill in reverse mode. The graft taken inside the device is used to replace the defect, and the soft tissues are sutured in layers. The disadvantage of this device for taking bone grafts and forming bone canals is the use of a drilling device, which determines the subjectivity of monitoring the interventions, where a rotating milling cutter twists the mucous membrane and periosteum with their subsequent detachment from the bone, which determines the aggressiveness of the instrument and can lead to overheating of the surrounding tissues.

To take the graft from the retromolar region of the upper jaw, a useful model is used (patent No. 125835 dated 20.03.2013), which includes a cylindrical body with a cutting part in the form of “fish scales”, a pusher cylinder. Rounded extension is formed on proximal part of pusher cylinder. A special handle is placed on the cylindrical body and struck with a surgical hammer, where the taken material is removed. The obtained graft in the form of a column is removed from the inner part of the body by means of a pusher cylinder, and soft tissues are sutured layer-by-layer. The disadvantage of the useful model is that when taking bone tissue, a hammer is used to strike the body of the handle of the device, which causes discomfort in patients and psycho-emotional overstrain during the intervention, which leads to the likelihood of some complications.

The general disadvantages of the above solutions are the insufficient quality of autografts due to the violation of its morphological structure, which eliminates the possibility of taking a three-layer transplant from the connective tissue of the mucous membrane with periosteum, cortical and spongy bone tissue.

CONCLUSION

Our device is characterized by minimally invasive, which makes it possible to take a three-layer autograft (connective tissue of the mucous membrane with periosteum, cortical and spongy bone tissue) from the tubercle of the upper jaw with simultaneous dental implantation with pronounced bone and soft tissue defects of the alveolar process effectively and safely, standard implantation with alveolar atrophy process and condom the socket of the removed tooth. Reciprocating movements with the hand provide controlled effort and a complete three-layer autograft with a significant reduction in surgical time.

Application of the proposed device at sampling of three-layer autograft from tubercle of upper jaw makes it possible to extract combined soft-tissue bone block of small diameter with preservation of surrounding bone tissue with imitation of removed tooth socket, which makes it possible to reduce edema and pain in postoperative period, providing predicted clinical effect. Arrangement of through oval grooves on opposite sides of mucotome-osteotome for sampling of three-layer autograft from upper jaw tubercle provides optimal extraction of triplagraft from milling cutter. In general, the stated advantages of our device create maximum efficiency, safety and ease of use of this medical device. This device is aimed at preserving the donor site.

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