Original Research

https://doi.org/10.36377/ET-0204

Method of orthodontic expansion, lengthening and maintaining a normalised upper dental arch in cases of congenital cleft lip and palate during the transitional dentition period prior to bone grafting of the alveolar ridge

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Abstract

AIM. The aim of this study was to improve the effectiveness of complex therapy for children with congenital cleft lip and palate during the mixed dentition period prior to maxillary alveolar bone grafting by developing an orthodontic treatment method.

MATERIALS AND METHODS. The developed method was applied at the Dental Clinical Center of the Republic Hospital No. 1 – National Center of Medicine (Yakutsk, Russian Federation) in 101 patients aged 6–7 years who underwent cheiloplasty and uranoplasty between 2007 and 2025 prior to bone grafting.

RESULTS. The method was applied after the eruption of the central incisors, before the formation and eruption of the permanent canine on the cleft side. This method ensures a fixed, normal position of all permanent and deciduous teeth, including those bordering the alveolar ridge cleft, creating optimal conditions for bone grafting of the maxillary alveolar ridge. The developed orthodontic treatment method ensures a fixed, normal position of all permanent and deciduous teeth in the dental arch, including those bordering the alveolar ridge cleft, and also creates favorable conditions for proper jaw growth and development.

CONCLUSIONS. The use of the proposed orthodontic treatment method promotes optimal restoration of dental and jaw function and enables timely and efficient implementation of comprehensive medical and social measures aimed at restoring the anatomical integrity of oral organs and tissues, as well as the child's social adaptation.

Keywords: congenital cleft lip and palate, mixed dentition, titanium-molybdenum arch, wire construction, Delar mask, alveolar bone grafting

Article information: received – 14.01.2026; revised – 03.03.2025; accepted – 29.03.2026

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

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

For citation: Koryakina N.V., Ushnitsky I.D., Davydova M.M., Petrova V.P., Uvarov D.M. Method of orthodontic expansion, lengthening and maintaining a normalised upper dental arch in cases of congenital cleft lip and palate during the transitional dentition period prior to bone grafting of the alveolar ridge. *Endodontics Today.* 2026;24(2):408–416. https://doi.org/10.36377/ET-0204

Способ ортодонтического расширения, удлинения и сохранения нормализованной верхней зубной дуги при врожденной расщелине губы и неба в период сменного прикуса перед костной пластикой альвеолярного отростка

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Резюме

ЦЕЛЬ. Повышение эффективности комплексной терапии детей с врожденной расщелиной губы и неба в период сменного прикуса перед костной пластикой альвеолярного отростка верхней челюсти путем разработки способа ортодонтического лечения.

МАТЕРИАЛЫ И МЕТОДЫ. Разработанный способ применялся на базе стоматологического отделения Республиканской больницы № 1 – Национального центра медицины им. М.Е. Николаева (Якутск), у 101 пациента в возрасте 6–7 лет после хейло- и уранопластики за период с 2007 по 2025 г. перед проведением костной пластики.
РЕЗУЛЬТАТЫ. Способ применен после прорезывания центральных резцов, до формирования и прорезывания постоянного клыка на стороне расщелины, который обеспечивает фиксированное нормальное положение всех постоянных и временных зубов, в том числе граничащих с расщелиной альвеолярного отростка, которые создают оптимальные условия для проведения костной пластики альвеолярного отростка верхней челюсти. Разработанный метод ортодонтического лечения обеспечивает фиксированное нормальное положение всех постоянных и временных зубов зубной дуги, в том числе граничащих с расщелиной альвеолярного отростка, а также создает благоприятные условия для правильного роста и развития челюстей.
ВЫВОДЫ. Использование предложенного способа ортодонтического лечения способствует оптимальному восстановлению функций зубочелюстной системы, а также позволяет своевременно произвести оперативную реализацию комплексных медико-социальных мероприятий, направленных на восстановление анатомической целостности органов и тканей полости рта, а также социальную адаптацию ребенка.

Ключевые слова: врожденная расщелина губы и неба, сменный прикус, титан-молибденовая дуга, проволочная конструкция, маска Деляра, костная пластика альвеолярного отростка

Информация о статье: поступила – 14.01.2026; исправлена – 03.03.2025; принята – 29.03.2026

Конфликт интересов: Авторы сообщают об отсутствии конфликта интересов.

Благодарности: Финансирование и индивидуальные благодарности для декларирования отсутствуют.

Для цитирования: Корякина Н.В., Ушницкий И.Д., Давыдова М.М., Петрова В.П., Уваров Д.М. Способ ортодонтического расширения, удлинения и сохранения нормализованной верхней зубной дуги при врожденной расщелине губы и неба в период сменного прикуса перед костной пластикой альвеолярного отростка. *Эндодонтия Today.* 2026;24(2):408–416. https://doi.org/10.36377/ET-0204

INTRODUCTION

Despite the widespread study of congenital cleft of the upper lip and palate, their problems of prevention and treatment remain unresolved, as they relate to severe congenital dysgenes of the maxillofacial region [1; 2]. At the same time, in addition to local morphological pathologies, individuals with congenital cleft lip and palate have common systemic disorders of the functional activity of various organs and systems of the body, which cause a marked decrease in the quality of life of children [3; 4]. In this regard, such congenital anomalies of the organs and tissues of the oral cavity require the need for multi-stage and comprehensive rehabilitation measures [1; 5]. Orthodontic treatment at the stages of therapeutic and preventive measures in a removable bite is extremely important, which are aimed at normalizing the position of teeth and dentition, restoring the shape of the dental arch before bone grafting of the alveolar process of the upper jaw [2; 6; 7].

It should be noted that the orthodontic aspects of the therapeutic effect are aimed at eliminating the congenital defect of the alveolar process by moving teeth in the dental arch in the period before the formation and eruption of a permanent canine tooth on the side of the cleft, which create favorable conditions for restoring speech and facial shape [5]. At the same time, normalization of fragments of the alveolar process of the upper jaw causes the development of bone tissue, which is especially important when the canine tooth erupts on the side of the cleft [7–9]. In this regard, orthodontic treatment of congenital cleft lip and palate remains one of the urgent problems of modern medicine [1; 3; 10]. Taking into account the above, the direction of this research work was chosen.

AIM

Improving the effectiveness of complex therapy of children with congenital cleft lip and palate during the period of replacement bite before bone grafting of the alveolar process of the upper jaw by developing a method of orthodontic treatment.

MATERIALS AND METHODS

The developed method of orthodontic treatment for the expansion, elongation and preservation of the normalized upper dental arch in congenital cleft lip and palate during the period of replacement bite before bone grafting of the alveolar process (patent application No. 2026100044, dated 06.01.2026) was used on the basis of the dental department of the Dental Clinical Center of the Republic Hospital No. 1 – National Center of Medicine (Yakutsk, Russian Federation) in 101 patients aged 6–7 years for the period from 2007 to 2025 after cheilo-, uranoplasty and before canine eruption on the side of the cleft before bone grafting of the alveolar process of the upper jaw.

The method is applied after the eruption of the central incisors, before the formation and eruption of the permanent canine tooth on the side of the cleft after cheilo- and uranoplasty with underdevelopment of the upper jaw in the sagittal and transversal planes, narrowing and shortening of the upper dental arch, mesial ratio of the dental arches, reverse incisor occlusion, adentia of the permanent lateral incisor on the side of the cleft, adentia of temporary canines and molars the upper dental arch using a titanium-molybdenum arc wire structure with a cross-section diameter of 0.19×0.25. At the same time, the stages of leveling and aligning the teeth of the upper jaw were carried out, then the arch

was replaced with a titanium-molybdenum arch with stop loops in the area of permanent central incisors and missing temporary teeth to further preserve the normalized dental arch and stabilize the central incisors before bone grafting of the alveolar process of the upper jaw. To form a wire structure with loop-stoppers, impressions are taken from the upper jaw with a bracket system and a plaster model is cast. An individual wire structure with locking loops is formed on a titanium-molybdenum arc manually using Engle-Tweed forceps, covering the distal edges of the central incisors to avoid their displacement, as well as in the area of missing permanent lateral incisors, canines and premolars, in front of the first permanent molar on the right and left, taking into account the expansion and elongation of the upper the dental arch. Next, a titanium-molybdenum arc wire structure was installed in the patient's oral cavity and its correction was performed. The hinges of the titanium molybdenum arc wire structure serve as auxiliary elements in the area of missing teeth to fix rubber rods when wearing an extraoral Delar mask, which is used to eliminate retrognathia and reverse incisor occlusion, as well as to expand, lengthen and maintain a normalized upper dental arch. The construction is fixed at the stage of orthodontic treatment before bone grafting and is used after surgery on the alveolar process of the upper jaw in the retention period for 6 months. After that, the device is removed from the oral cavity and further orthodontic treatment is performed using non-removable and removable orthodontic devices to further normalize the position of teeth, dentition and bite.

The research was approved by the Ethics Committee of the North-Eastern Federal University No. 44 dated 08.10.2025, decision No. 3 in compliance with ethical rules and standards of medical research in the Russian Federation.

The statistical evaluation was carried out using Microsoft Excel software, 2020 (USA). At the same time, the studied parameters were formed based on the estimated totality of clinical manifestations of congenital malformations.

RESULTS

The main purpose of the practical application of the developed method is to fix the normalized position of permanent and temporary teeth of the upper jaw, including those bordering the cleft, creating optimal conditions before bone grafting of the alveolar process. The method is shown in drawings, where a child with congenital cleft lip and palate before orthodontic treatment using a titanium-molybdenum structure before bone grafting of the alveolar process of the upper jaw (Fig. 1); the child's oral cavity before orthodontic treatment with a wire structure (Fig. 2); orthopantomogram before bone grafting of the alveolar process of the upper jaw (Fig. 3); the patient at the stage of leveling and alignment of teeth (Fig. 4); plaster model with a normalized position of the central incisors of the upper jaw from the upper jaw, wire structure and Tweed-Engle forceps (Fig. 5); formation of stop loops in the area of permanent central incisors and missing temporary teeth for individual adjustment of the position of the central incisors, expansion and elongation of the dental arch of the upper jaw on a titanium-molybdenum arch wire structure (Fig. 6); installed titanium-molybdenum arc wire structure at the treatment stage in the period before the fang erupts on the side of the cleft (Fig. 7); an extraoral Delarator mask with a rubber rod and a titanium-molybdenum arc wire structure in the oral cavity to eliminate retrognathia and reverse incisor occlusion, as well as to expand and lengthen the upper dental arch (Fig. 8); cone-beam computed tomography images before bone grafting of the alveolar process of the upper jaw (Fig. 9); orthopantomogram and cone-beam computed tomography images after plastic surgery of the alveolar process of the upper jaw (Fig. 10).

Fig. 1. A child with congenital cleft lip and palate before orthodontic treatment using a titanium-molybdenum construction before bone grafting of the alveolar process of the upper jaw: *A* – front view; *B* – left view; *C* – right view; *D* – smiling view

Рис. 1. Ребенок с врожденной расщелиной губы и неба до ортодонтического лечения с использованием титан-молибденовой конструкции перед костной пластикой альвеолярного отростка верхней челюсти: *A* – вид спереди; *B* – вид слева; *C* – вид справа; *D* – вид с улыбкой

A B C

Fig. 2. The child's oral cavity before orthodontic treatment with a wire structure:
A – front view; *B* – left view; *C* – right view

Рис. 2. Полость рта ребенка до ортодонтического лечения с проволочной конструкцией:
A – вид спереди; *B* – вид слева; *C* – вид справа

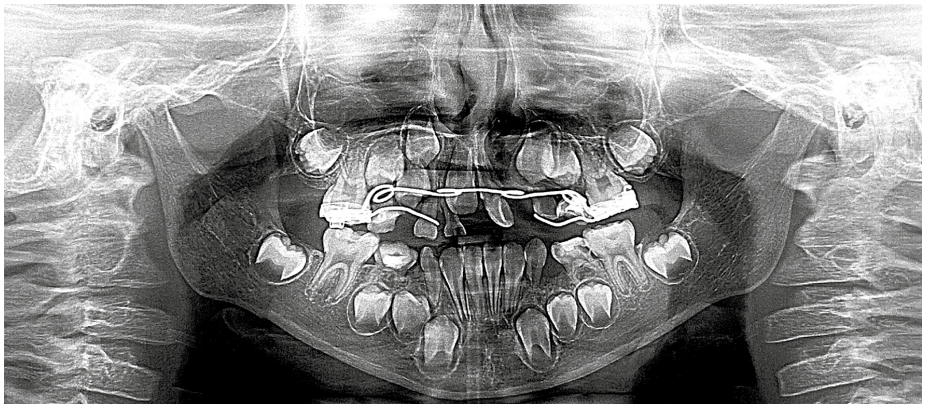
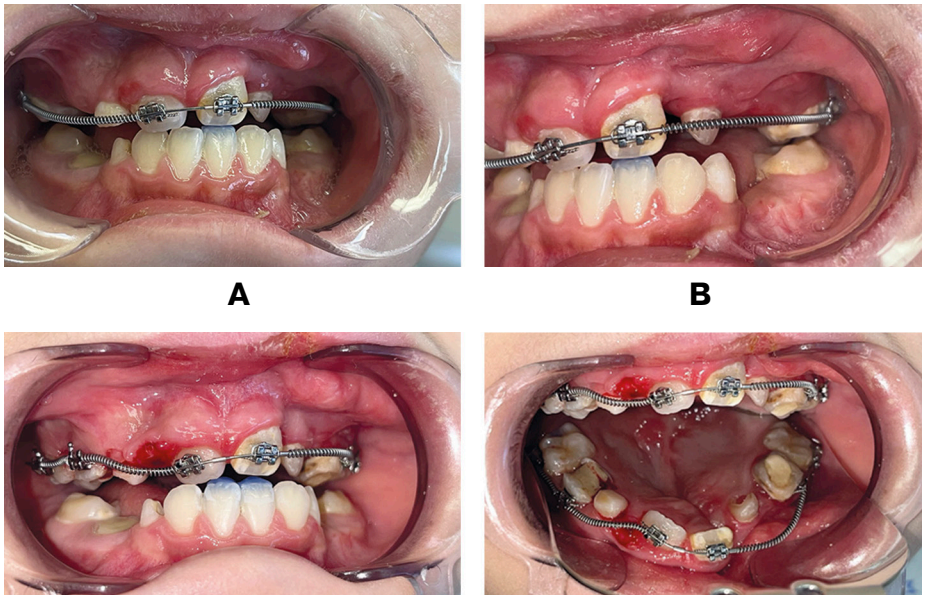


Fig. 3. Orthopantomogram before bone grafting of the alveolar process of the upper jaw

Рис. 3. Ортопантомограмма до костной пластики альвеолярного отростка верхней челюсти



A B C D

Fig. 4. The patient at the stage of leveling and alignment of teeth:
A – front view; *B* – left view; *C* – right view; *D* – from the palate

Рис. 4. Пациент на этапе нивелирования и выравнивания зубов:
A – вид спереди; *B* – вид слева; *C* – вид справа; *D* – со стороны неба

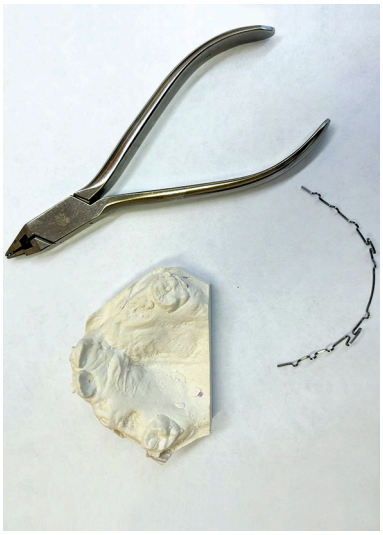
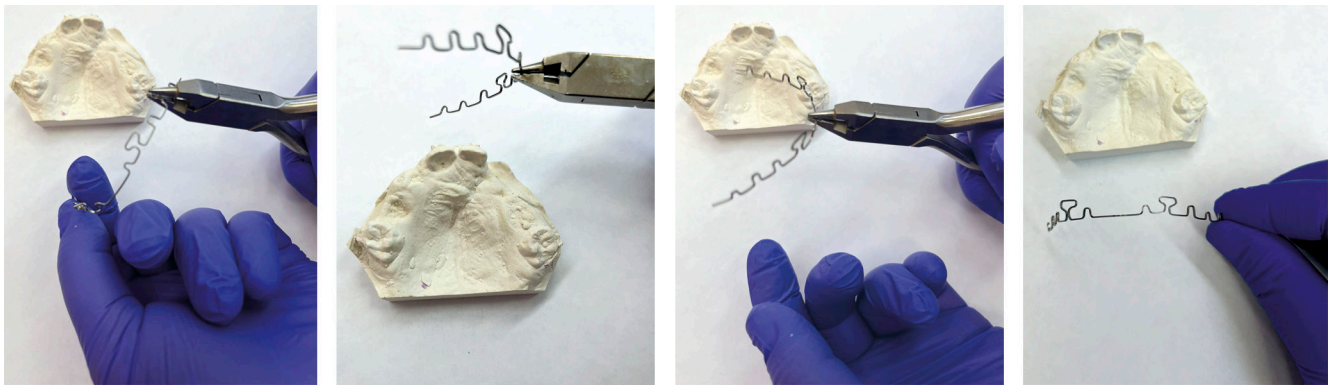


Fig. 5. Plaster model with a normalized position of the central incisors of the upper jaw with congenital cleft lip and palate, wire structure and Tweed-Engle forceps

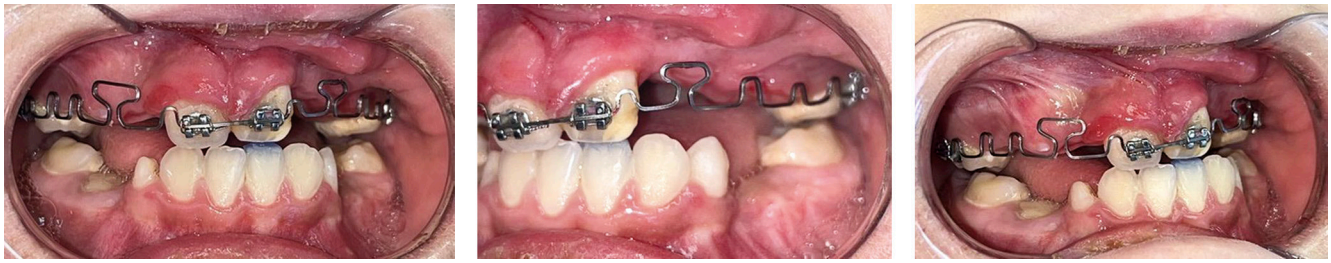
Рис. 5. Гипсовая модель с нормализованным положением центральных резцов верхней челюсти с врожденной расщелиной губы и неба, проволочная конструкция и щипцы «Твида-Энгля»



A B C D

Fig. 6. Formation of stop loops in the area of permanent central incisors and missing temporary teeth for individual adjustment of the position of the central incisors, expansion and elongation of the dental arch of the upper jaw on a titanium-molybdenum arch wire structure:
A – stop loops; *B* – right view; *C* – top view; *D* – view finished construction

Рис. 6. Формирование петель-стопоров в области постоянных центральных резцов и отсутствующих временных зубов для индивидуальной корректировки положения центральных резцов, расширения и удлинения зубной дуги верхней челюсти на проволочной конструкции из титан-молибденовой дуги:
A – петли-стопоры; *B* – вид справа; *C* – вид сверху; *D* – вид готовой конструкции



A B C

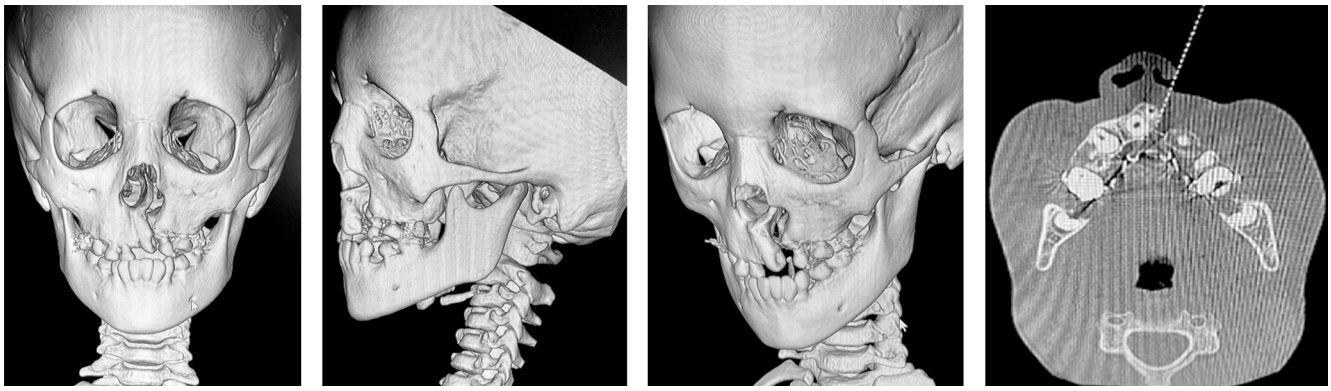
Fig. 7. Installed titanium-molybdenum arc wire structure at the treatment stage in the period before the fang erupts on the side of the cleft: *A* – front view; *B* – left view; *C* – right view

Рис. 7. Установленная проволочная конструкция из титан-молибденовой дуги на этапе лечения в период до прорезывания клыка на стороне расщелины: *A* – вид спереди; *B* – вид слева; *C* – вид справа

A B C

Fig. 8. An extraoral Delar mask with a rubber rod and a titanium-molybdenum arc wire structure in the oral cavity to eliminate retrognathia and reverse incisor occlusion, as well as to expand and lengthen the upper dental arch:
A – appearance of the extraoral Delar mask on the left; *B* – oral cavity view on the left; *C* – oral cavity right view

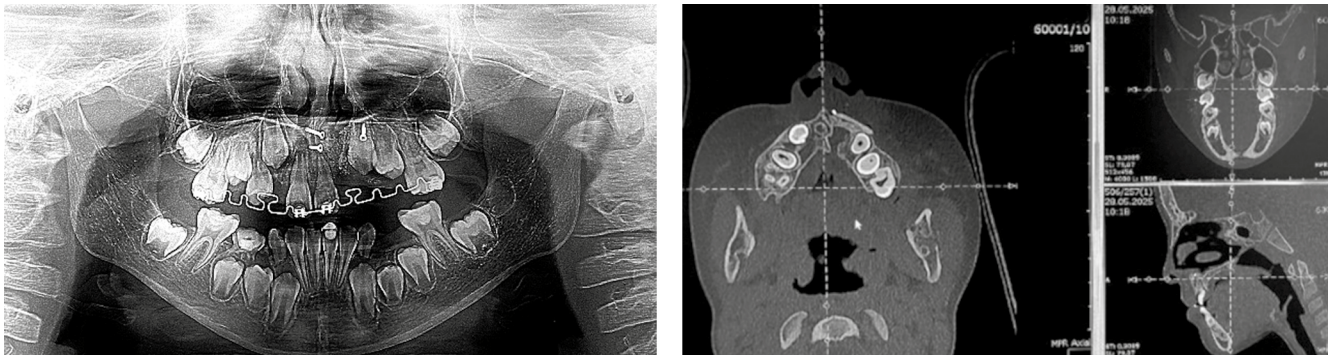
Рис. 8. Внеротовая маска Деляра с резиновой тягой и проволочной конструкцией из титан-молибденовой дуги в полости рта для устранения ретрогнатии и обратной резцовой окклюзии, а также для расширения и удлинения верхней зубной дуги: *A* – внешний вид внеротовой маски Деляра слева; *B* – полость рта вид слева; *C* – полость рта вид справа



A B C D

Fig. 9. Cone-beam computed tomography images before bone grafting of the alveolar process of the upper jaw: *A* – front view; *B* – left view; *C* – top view; *D* – cross-section view

Рис. 9. Снимки конусно-лучевой компьютерной томографии до проведения костной пластики альвеолярного отростка верхней челюсти: *A* – вид спереди; *B* – вид слева; *C* – вид сверху; *D* – вид в срезе



A B

Fig.10. Orthopantomogram (*A*) and cone-beam computed tomography images (*B*) after bone grafting of the alveolar process of the upper jaw

Рис. 10. Ортопантомограмма (*A*) и снимки конусно-лучевой компьютерной томографии (*B*) после костной пластики альвеолярного отростка верхней челюсти

A clinical example

Patient A., aged 7 years turned (on 15.10.2024) to the dental department with a diagnosis of underdevelopment of the upper jaw, through-the-left-sided congenital cleft lip and palate, shortening and narrowing of the dental arch in the sagittal and transversal planes, mesial ratio of the dental arches, retrognathia, reverse incisor dysocclusion, adentia of the permanent lateral incisor on the side of the cleft, adentia of the temporary canines and molars of the upper dental arch, anomaly of the position of the upper central incisors, the condition after cheilo- and uranoplasty.

Objectively: on external examination, there is a deformity of the left wing of the nose and the presence of a scar on the upper lip, an asymmetry of the face, and a shortening of the lower third of the face. Upon examination of the oral cavity, there is a left-sided cleft of the alveolar process of the upper jaw, underdevelopment of the upper jaw, retrognathia, mesioocclusion, and reverse incisor dysocclusion.

Based on clinical and cephalometric data, evaluation and analysis of the results of cone-beam computed tomography and orthopantomography, in order to prepare for bone grafting of the alveolar process, the patient had a fixed partial braces system on the upper jaw. At the same time, orthodontic treatment was performed using a titanium-molybdenum arc wire structure with a cross-section diameter of 0.19×0.25. At the beginning, casts were taken from the upper and lower jaw, control and working models were cast, and a permanent bracket system was fixed in the area of the central incisors 1.1 and 2.1, as well as on the permanent first molars 1.6 and 2.6. Next, the stages of leveling and aligning the teeth of the upper jaw were carried out, starting with nickel-titanium arches with a cross-section diameter of 0.13, 0.16, 0.18×0.25 using opening springs and protective silicone tubes, then the arches were replaced with a titanium-molybdenum arch with stopper loops in the area of permanent central incisors and missing temporary teeth for further expansion,

elongation and preservation of the normalized upper dental arch, stabilization of the central incisors for bone grafting of the alveolar process. To form a wire structure with stop loops, an impression was taken from the upper jaw with a bracket system and a plaster model was cast. An individual wire structure with locking loops was formed on a titanium-molybdenum arc in the area of permanent central incisors and missing temporary teeth in order to stabilize the central incisors using Engle-Tweed forceps, covering the distal edges of the central incisors to avoid their displacement, as well as in the area of missing lateral incisors, canines and premolars, before the first a permanent molar on the right and left of the upper jaw, taking into account the expansion and elongation of the dental arch.

10.02.2025. Before bone grafting, the patient underwent the installation of a titanium-molybdenum arch wire structure in the oral cavity with an emphasis on the first permanent molars, taking into account the expansion and elongation of the upper dental arch and its correction. In this case, the hinges of a titanium-molybdenum arc wire structure with a cross-section diameter of 0.19×0.25 serve as additional elements for fixing rubber rods in the area of missing temporary teeth when wearing an extraoral Delar mask, which was used to eliminate retrognathia and reverse incisor occlusion.

08.04.2025. During the control examination of the patient, the use of a titanium-molybdenum arch wire structure contributed to the expansion, elongation and preservation of the normalized upper dental arch, the position of the central incisors of the upper jaw, which formed the correct semi-elliptical shape of the dental arch, which is the best option for surgical intervention. The patient was referred to the Department of pediatric Maxillofacial surgery for bone grafting of the alveolar process of the upper jaw. Next, the design was used for 6 months in the retention period after surgery on the alveolar process of the upper jaw. Then the structure was removed from the oral cavity and further orthodontic treatment was continued using fixed and removable devices.

The use of an orthodontic treatment method to maintain a normalized dental arch in patients with acute renal failure during the period of replacement bite before alveolar process plastic surgery has advantages:

– expands the dental arch of the upper jaw for its normal formation;

– lengthens the upper dental arch for optimal development of the maxillary system;

– preserves the normalized upper dental arch in case of congenital cleft lip and palate during the period of replacement bite;

– it is used during the replacement period, namely after the eruption of the central incisors and in the area of missing temporary teeth, before the formation and eruption of the permanent canine tooth on the side of the cleft to create optimal conditions before bone grafting of the alveolar process of the upper jaw;

– provides a fixed normal position of all permanent and temporary teeth of the dental arch, including those bordering the cleft of the alveolar process;

– creates favorable conditions for proper growth and development of the jaws;

– contributes to improving the effectiveness of comprehensive medical and social rehabilitation of children with acute respiratory viral infections;

– improves the quality of life of children with congenital cleft lip and palate, which contributes to the normalization of the child's physical development.

In addition, the use of the proposed technical solution contributes to the optimal restoration of the functions of the dental system, and also allows for the timely implementation of comprehensive medical and social measures and the adaptation of the child.

DISCUSSION

Currently, there are a sufficient number of methods of orthodontic treatment of congenital cleft lip and palate in a removable bite. So, there is an instrumental method for expanding the upper dentition (patent No. 2680136 dated 15.02.2019), which includes the use of 2 removable plate orthodontic devices for the upper and lower jaw with arc and clamp fixation. In this case, the device for the upper jaw is made with a sawed screw, which leads to the expansion of the upper dentition and the movement of the teeth in the transversal direction and their removal from the palatal position due to the existing springs. A removable structure with occlusal pads covering the cutting edges of the frontal group of teeth and chewing surfaces is made on the dentition of the lower jaw. The disadvantage of the known solution is the use of removable orthodontic devices to expand the upper dentition, namely, to normalize the position of the canine tooth bordering the cleft during the period of replacement bite, which lead to sectoral expansion without taking into account the individual position of each tooth in space.

At the same time, there is a known method of orthodontic treatment of unilateral complete clefts of the upper jaw in children with a removable bite (patent No. 2549670 dated 27.04.2015), which uses a design with crowns for the first permanent molar and temporary canines. In this case, the screw and beams are located perpendicular to the interdental space of the first premolar and temporary canine, and the beams are located at one end to the crown. The disadvantage of this solution is the rigid frame fixation of the device, in which the upper dentition expands sectorially and transversally without moving the teeth in the anterior part of the upper jaw, which limits treatment in the lateral groups of teeth.

An orthodontic kit is known to eliminate the primary deformation of the alveolar process of the upper jaw (see patent No. 2803011 dated 09.05.2023), used in patients with cleft lip and palate after cheilo and palatinoplasty, containing the first upper jaw mounting device, the second lower jaw mounting device, a plastic mouthguard for the front teeth and at least one elastic rod according to class III, while the first upper jaw mounting device is made in the form of orthodontic rings interconnected by a palatine clasp and equipped with palatine locks for detachable connection with a "Quadhelix" having a semicircular shape on the side of the frontal teeth, the

second lower jaw mounting device is made in the form of orthodontic rings interconnected by a lingual arch with a lingual flap made of button clamps and equipped with buccal guides placed on the buccal surfaces of the rings, connected to the lingual arch by left and right fastening beams and made with end hooks for installing elastic rods in the canine region, and mouth guards on the front the teeth are equipped with a hook for elastic traction, oriented towards diastasis, moreover, tubes with hooks for elastic traction are installed on the buccal surfaces of the orthodontic rings of the first mounting device on the upper jaw, while on the side of the large fragment of the upper jaw, the palatine guide has a length for fitting in the area of the first temporary molar, and on the side of the small fragment of the upper jaw, the palatine guide has a length for fitting to the first temporary molar and canine. The buccal surface of the orthodontic ring is also equipped with a buccal guide with a hook for elastic traction in the canine region. The disadvantage of the known solution using an orthodontic kit is the lateral displacement of the teeth of the upper dentition without taking into account the mesiodistal position of all teeth in three mutually perpendicular planes, which are necessary to prepare for reconstructive surgical plastic surgery of the alveolar process in children with congenital cleft lip and palate.

CONCLUSION

The evaluation and analysis of the practical application of the developed method of orthodontic treatment characterizes its effectiveness, which are associated with the expansion, elongation and preservation of a normalized dental arch in children with congenital cleft lip and palate during the period of alternating bite, namely after the eruption of the central incisors, before the formation and eruption of a permanent canine tooth on the side of the cleft. The method provides a fixed normal position of the teeth of the dental arch, including those bordering the cleft of the alveolar process, creating optimal conditions for bone grafting of the alveolar process of the upper jaw. This creates favorable conditions for the normal development and eruption of permanent teeth and bone tissue, which significantly improves the medical and social rehabilitation of children.

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All authors approved the manuscript (version for publication), and also agreed to be responsible for all aspects of the work, ensuring proper consideration and resolution of issues related to the accuracy and integrity of any part of it.

ВКЛАД АВТОРОВ

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Все авторы одобрили рукопись (версию для публикации), а также согласились нести ответственность за все аспекты работы, гарантируя надлежащее рассмотрение и решение вопросов, связанных с точностью и добросовестностью любой ее части.