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СОДЕРЖАНИЕ | CONTENT

1. Шарипов Хуршед Саиджонович, Ризаев Жасур Алимджанович, Ашуров Гаюр Гафурович РАСПРОСТРАНЕННОСТЬ ЗЛОКАЧЕСТВЕННЫХ ОНКОЛОГИЧЕСКИХ ЗАБОЛЕВАНИЙ В УЗБЕКИСТАНЕ.....	7
2. Икрамова Шахзода Анваровна, Ризаев Жасур Алимжанович ДИНАМИКА ИЗМЕНЕНИЯ КЛИНИЧЕСКИХ ПОКАЗАТЕЛЕЙ СОСТОЯНИЯ ТВЕРДЫХ ТКАНЕЙ ЗУБОВ И ПАРОДОНТА У ДЕТЕЙ С ХРОНИЧЕСКИМ ГАСТРОДУОДЕНИТОМ.....	11
3. Xamraeva Nilufar Xamzaevna, Turayeva Feruza Abdurashidovna ODAM PAPILLOMAVIRUSI BILAN KASALLANGAN BEMORLARDA OG'IZ BO'SHLIG'I SHILLIQ QAVATI KASALLIKLARINING KLINIK VA PATOGENETIK XUSUSIYATLARI.....	16
4. Асадова Гульнара Межнун кизи ЗАБОЛЕВАНИЙ ПАРОДОНТА НА ФОНЕ БОЛЕЗНИ ЖЕЛУДОЧНО-КИШЕЧНОГО ТРАКТА (ОБЗОР ЛИТЕРАТУРЫ).....	20
5. G'afforov Sunatullo Amrullayevich, Shamsiyeva Mahfuza Olimjon qizi BOLALAR SEREBRAL FALAJINING SPASTIK SHAKLLARIDA TISH-JAG', NUTQ VA HALQUM BUZILISHLARINI TASHXISLASH, DAVOLASH VA REABILITATSIYANI TAKOMILLASHTIRISH.....	25
6. Бургутова Умидахон Мухаммаджоновна, Исакова Зухра Шарифкуловна ОПТИМИЗАЦИЯ ЛЕЧЕНИЯ ВТОРИЧНОЙ АДЕНТИИ У ПАЦИЕНТОВ С КОМОРБИДНОЙ ПАТОЛОГИЕЙ.....	30
7. Шарипов Хуршед Саиджонович ОЦЕНКА КАЧЕСТВА СПЕЦИАЛИЗИРОВАННОЙ СТОМАТОЛОГИЧЕСКОЙ ПОМОЩИ ПРИ ХИМИОЛУЧЕВОЙ ТЕРАПИИ.....	34
8. Muminova Dilnoza Raximovna EKOLOGIK BARKARORLIK, STOMATOLOGIYA VA INSON SALOMATLIGI MUAMMOLARINI ILMYI-AMALIY- TAJRIBALARDA ASOSLASH VA YECHIMLARI.....	39
9. Каршиев Шавкат Гофурович ХАРАКТЕРИСТИКА СОЧЕТАННЫХ ЧЕРЕПНО-ЧЕЛЮСТНО-ЛИЦЕВЫХ ПОВРЕЖДЕНИЙ ПО ДАННЫМ РЕТРОСПЕКТИВНОГО ИССЛЕДОВАНИЯ.....	45
10. Эргашева Иродахон Уткирбек кизи, Хайдаров Артур Михайлович СТОМАТОЛОГИЧЕСКИЙ СТАТУС У ЖЕНЩИН В КЛИМАКТЕРИЧЕСКОМ ПЕРИОДЕ: МОЛЕКУЛЯРНЫЕ МЕХАНИЗМЫ И КЛИНИЧЕСКИЕ ПРОЯВЛЕНИЯ.....	49
11. Джураева Ферангиз Хакимовна КЛИНИКО-РЕНТГЕНОЛОГИЧЕСКАЯ ХАРАКТЕРИСТИКА ДЕСТРУКТИВНЫХ ИЗМЕНЕНИЙ В ПАРОДОНТЕ У ПАЦИЕНТОВ С ДЕКОМПЕНСИРОВАННОЙ ФОРМОЙ ХРОНИЧЕСКОГО ТОНЗИЛЛИТА.....	54
12. Хожимуродов Бурхон Равшанович СОВЕРШЕНСТВОВАНИЕ ТАКТИКИ СТОМАТОЛОГИЧЕСКОЙ ПОМОЩИ ПАЦИЕНТАМ С ЭПИЛЕПСИЕЙ, СОПРОВОЖДАЮЩЕЙСЯ ГИПЕРТРОФИЧЕСКИМ ГИНГИВИТОМ.....	58
13. Нарзиева Дилфуза Бахтиёрловна, Гаппаров Жахонгир Зафарович «УСОВЕРШЕНСТВОВАНИЕ МЕТОДОВ ЛЕЧЕНИЯ ГИПЕРТОНУСА ЖЕВАТЕЛЬНЫХ МЫШЦ КОМПЛЕКСНЫМ ФИЗИОТЕРАПЕТИЧЕСКИМ И МЕДИКАМЕНТОЗНЫМ ПОДХОДОМ» (ОБЗОР ЛИТЕРАТУРЫ).....	62
14. Raxmonova Shoxsanom Raxim qizi, Norova Mavjuda Bahodurovna SURUNKALI BUYRAK YeTISHMOVCHILIGI BO'LGAN BOLALARDA TISH QATTIQ TO'QIMALARI ZARARLANISHLARINING PATOGENETIK MEKANIZMLARI.....	67
15. Narziyeva Dilfuza Baxtiyorovna, Xudoyqulov Sardor Sobirovich SURUNKALI QAYTALANUVCHI AFTOZ STOMATITNI KOMPLEKS DAVOLASHNING ZAMONAVIY USULLARI (ADABIYOTLAR SHARHI).....	72

16. Orifxo‘jayeva Mehriniso Valijonovna, Norova Mavjuda Bahodurovna SURUNKALI LEYKOZLI BEMORLARDA OG‘IZ BO‘SHLIG‘I BIOTSENOZI BUZILISHLARI NATIJASIDA KELIB CHIQUVCHI STOMATOLOGIK KASALLIKLAR DIAGNOSTIKASI VA KOMPLEKS DAVOLASH USULLARINI TAKOMILLASHTIRISH.....	77
17. Qodirova Maftunabonu Komilovna, Xabibova Nazira Nasulloevna NEONATAL DAVRDA OG‘IZ BO‘SHLIG‘I KANDIDOZINING KLINIK-DIAGNOSTIK XUSUSIYATLARI VA KOMPLEKS DAVOLASH STRATEGIYALARINI TAKOMILLASHTIRISH.....	82
18. Jabborova Feruza Uzoqovna, Elova Hanifa Rahmat qizi BACHADON BO‘YNI SARATONIDA OG‘IZ MUKOZITINING OG‘IRLIGINI STOMATOLOGIK KUZATISHDA OG‘IZ SUYUQLIGIDAGI IMMUNOGLOBULIN DARAJASINING QIYMATI.....	87
19. Хамраев Мирали Шерали ўғли, Гаффоров Суннатullo Амруллоевич, Пулатова Райхон Саидумаровна РОЛЬ ДЕНТАЛЬНОЙ ИМПЛАНТАЦИИ И ЕЁ ПРОТОКОЛИРОВАНИЕ В ОРТОПЕДИЧЕСКОМ ПРОТЕЗИРОВАНИИ ДЕФЕКТОВ ЗУБНЫХ РЯДОВ (ОБЗОР ЛИТЕРАТУРЫ).....	91
20. Aslonova Gulnora Baxshiloyevna, Gafforov Sunnatullo Amrulloevich YUZ-JAG‘ SOHASI ONKOLOGIK PATOLOGIYALARIDA TASHXISLASH, DAVOLASH VA STOMATOLOGIK REABILITATSIYAGA YONDASHUVLARI TO‘G‘RISIDA.....	96
21. Махмудова Углой Бахтиёрвна, Ибодуллаев Равшан Абдижаббар угли РЕНТГЕНОЛОГИЧЕСКАЯ ХАРАКТЕРИСТИКА ИЗМЕНЕНИЙ КОСТНОЙ ТКАНИ В ОТДАЛЁННЫЕ СРОКИ ПОСЛЕ ПРОТЕЗИРОВАНИЯ ПАЦИЕНТОВ МОСТОВИДНЫМИ ПРОТЕЗАМИ.....	101
22. Irgashev Shokhrukh Xasanovich, Aslamov Akbarjon Akobirovich TRANSFORMATION OF DENTAL DIAGNOSTICS: FROM ANATOMICAL IMPRESSIONS TO DIGITAL MODELS BASED ON CAD/CAM TECHNOLOGIES.....	105
23. Chakkanov Faxritdin Khusanovich, Abdullayeva Malikabonu Umedjanovna MODERN METHODS FOR THE CORRECTION OF MALOCCLUSION IN CHILDREN AND ADOLESCENTS USING INNOVATIVE REMOVABLE EXPANSION APPLIANCES.....	109
24. Исламова Нилуфар Бустановна, Набиева Маржона Уктамовна ОПТИМИЗАЦИЯ СПОСОБОВ УСТРАНЕНИЯ ОСЛОЖНЕНИЙ В ПЕРИОД ПРИВЫКАНИЯ ПАЦИЕНТОВ К СЪЕМНЫМ КОНСТРУКЦИЯМ.....	114
25. Нуритдинов Улугбек Акбарович, Фаттахов Равшан Абдурашидович, Хасанова Лола Эмильевна, Хамидова Дильбар Авдуновна АКСИОГРАФИЧЕСКОЕ ИССЛЕДОВАНИЕ ПРИ ОДНОСТОРОННИХ ВЫВИХАХ ДИСКОВ ВНЧС.....	120

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**MODERN METHODS FOR THE CORRECTION OF MALOCCLUSION IN CHILDREN AND ADOLESCENTS
USING INNOVATIVE REMOVABLE EXPANSION APPLIANCES**



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ANNOTATION

Malocclusion in children and adolescents represents one of the significant challenges in modern orthodontics, as it may lead to functional disturbances of the dentofacial system, aesthetic problems, and a reduced quality of life. In recent years, increasing attention has been paid to the use of innovative orthodontic appliances aimed at the early correction of developmental abnormalities of the dental arches. One of the promising treatment approaches involves the use of removable expansion appliances, which allow effective correction of transverse deformities of the dental arches and create favorable conditions for the proper formation of occlusal relationships.

The aim of the study is to substantiate the effectiveness of an innovative removable expander in the treatment of various types of malocclusion in children and adolescents. The study analyzes clinical and functional changes in the dentofacial system during orthodontic treatment. The obtained results may contribute to the improvement of early diagnostic and treatment methods for occlusal anomalies and enhance the effectiveness of orthodontic care in pediatric patients.

Keywords: malocclusion, orthodontic treatment, removable expander, dentofacial system, children and adolescents, orthodontic appliances, bite correction.

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**СОВРЕМЕННЫЕ МЕТОДЫ КОРРЕКЦИИ АНОМАЛИЙ ОККЛЮЗИИ У ДЕТЕЙ И ПОДРОСТКОВ С
ПРИМЕНЕНИЕМ ИННОВАЦИОННЫХ СЪЕМНЫХ РАСШИРЯЮЩИХ АППАРАТОВ**

АННОТАЦИЯ

Аномалии окклюзии у детей и подростков являются одной из актуальных проблем современной ортодонтии, поскольку они могут приводить к функциональным нарушениям зубочелюстной системы, эстетическим дефектам и ухудшению качества жизни пациентов. В последние годы особое внимание уделяется применению инновационных ортодонтических аппаратов, направленных на раннюю коррекцию нарушений развития зубных дуг. Одним из перспективных методов лечения является использование съемных расширяющих аппаратов, позволяющих эффективно корректировать поперечные деформации зубных рядов и создавать условия для правильного формирования окклюзионных взаимоотношений.

Целью исследования является обоснование эффективности применения инновационного съемного расширителя при лечении различных видов окклюзионных нарушений у детей и подростков. В работе анализируются клинические и функциональные изменения зубочелюстной системы в процессе ортодонтического лечения. Полученные результаты могут способствовать совершенствованию методов ранней диагностики и лечения окклюзионных аномалий, а также повышению эффективности ортодонтической помощи детям и подросткам.

Ключевые слова: аномалии окклюзии, ортодонтическое лечение, съемный расширитель, зубочелюстная система, дети и подростки, ортодонтические аппараты, коррекция прикуса.

Chakkanov Faxritdin Xusanovich
Abdullayeva Malikabonu Umedjanovna
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BOLALAR VA O'SMIRLARDA OKKLYUZIYA ANOMALIYALARINI INNOVATSION OLINADIGAN KENGAYTIRUVCHI APPARATLAR YORDAMIDA TUZATISHNING ZAMONAVIY USULLARI**ANNOTATSIYA**

Bolalar va o'smirlar orasida uchraydigan okklyuziya anomaliyalari zamonaviy ortodontiyaning dolzarb muammolaridan biri hisoblanadi. Ushbu patologiyalar tish-jag' tizimining funksional buzilishlariga, estetik nuqsonlarga hamda bemorlarning hayot sifatining pasayishiga olib kelishi mumkin. So'nggi yillarda tish yoylarining rivojlanishidagi buzilishlarni erta bosqichda tuzatishga qaratilgan innovatsion ortodontik apparatlarni qo'llashga katta e'tibor qaratilmoqda. Shunday istiqbolli usullardan biri bu olinadigan kengaytiruvchi apparatlar bo'lib, ular tish qatorlarining ko'ndalang deformatsiyalarini samarali tuzatish hamda to'g'ri okklyuzion munosabatlar shakllanishi uchun qulay sharoit yaratadi.

Ushbu tadqiqotning maqsadi bolalar va o'smirlarda turli xil okklyuziya buzilishlarini davolashda innovatsion olinadigan kengaytiruvchi apparatdan foydalanish samaradorligini asoslashdan iborat. Tadqiqot davomida ortodontik davolash jarayonida tish-jag' tizimida yuzaga keladigan klinik va funksional o'zgarishlar tahlil qilindi. Olingan natijalar okklyuziya anomaliyalarini erta aniqlash va davolash usullarini takomillashtirishga hamda bolalar ortodontik yordamining samaradorligini oshirishga xizmat qilishi mumkin.

Kalit so'zlar: okklyuziya anomaliyalari, ortodontik davolash, olinadigan kengaytiruvchi apparat, tish-jag' tizimi, bolalar va o'smirlar, ortodontik apparatlar, tishlashni tuzatish.

Relevance of the Study.

Malocclusion in children and adolescents remains one of the most prevalent problems in modern orthodontics and pediatric dentistry. According to numerous epidemiological studies, the prevalence of dentofacial anomalies among the pediatric population remains high and, in some regions, continues to increase. Occlusal disorders negatively affect not only the aesthetic appearance of the maxillofacial region but also the functional condition of the dentofacial system, including mastication, speech, and breathing. In addition, pronounced malocclusion may contribute to psychological discomfort, reduced self-confidence, and a decline in the overall quality of life of children and adolescents [2].

The development of occlusal anomalies is associated with a complex interaction of etiological factors. Among the most significant are hereditary predisposition, disturbances in craniofacial growth and development, harmful oral habits, dysfunction of the masticatory muscles, and early loss of primary teeth. These factors may lead to deformation of the dental arches, displacement of teeth, and disturbances in intermaxillary relationships, which ultimately result in the formation of dentofacial anomalies of varying severity [1,3].

Early diagnosis and timely orthodontic intervention during periods of active growth of the maxillofacial region are of particular importance. Childhood and adolescence represent the most favorable stages for orthodontic treatment, as the dentoalveolar structures demonstrate high biological plasticity and the ability to adapt to functional changes. Timely orthodontic correction can prevent the development of severe dentofacial deformities, reduce the need for complex orthodontic and prosthetic treatment in the future, and promote harmonious development of the dentofacial system [4].

In recent years, considerable attention has been devoted to the introduction of innovative orthodontic technologies aimed at improving the effectiveness of treatment of dentofacial anomalies. Among these methods, removable expansion appliances occupy a special place, as they allow clinicians to influence the growth and development of dental arches, correct transverse discrepancies of the jaws, and create favorable conditions for the formation of proper occlusal relationships. Removable orthodontic appliances are characterized by relatively simple construction, the possibility of individual adjustment according to the anatomical features of the patient, and high effectiveness in the treatment of young patients[5].

Despite the widespread use of orthodontic appliances in clinical practice, issues related to improving their therapeutic efficiency and scientifically substantiating the application of innovative removable expanders in the treatment of malocclusion in children and adolescents remain insufficiently explored. Further research is required to refine diagnostic approaches, optimize treatment strategies, and evaluate clinical outcomes based on modern functional and morphological indicators[7].

Therefore, the study aimed at substantiating the use of innovative removable expansion appliances for the correction of malocclusion in children and adolescents is highly relevant from both scientific and practical perspectives. The results of such research may contribute to the improvement of orthodontic treatment methods, enhance their clinical effectiveness, and promote better functional and aesthetic outcomes in the dentofacial system of pediatric patients[6,8].

Malocclusion represents one of the most common pathologies of the dentofacial system in children and adolescents and remains an important issue in contemporary orthodontics. Disturbances in occlusal relationships can significantly affect the morphological and functional state of the maxillofacial complex. In addition to aesthetic problems, such anomalies may lead to impaired mastication, speech disorders, temporomandibular joint dysfunction, and uneven distribution of masticatory load on the teeth and periodontal tissues. These factors may further contribute to the development of secondary dental and periodontal diseases.

The formation of dentoalveolar anomalies is influenced by numerous local and systemic factors. Among them are genetic predisposition, disturbances in craniofacial growth, early loss of primary teeth, prolonged oral habits, and functional imbalance of the orofacial muscles. Such conditions may disrupt the normal development of the dental arches and intermaxillary relationships, which eventually results in different types of occlusal abnormalities [9].

Early orthodontic intervention plays a crucial role in preventing the progression of dentofacial deformities. The period of active growth in childhood and adolescence provides favorable biological conditions for the correction of anomalies in the dentoalveolar system. During this stage, orthodontic treatment can effectively influence jaw growth, dental arch development, and occlusal relationships, thereby ensuring more stable and predictable treatment outcomes.

In recent years, orthodontics has increasingly focused on the development and clinical implementation of innovative treatment technologies. Removable expansion appliances are widely used for the correction of transverse discrepancies of the dental arches and for the normalization of occlusal relationships in growing patients. The use of such appliances allows controlled expansion of the dental arches, improvement of functional balance within the stomatognathic system, and the prevention of more severe skeletal deformities [11,12].

However, despite the growing interest in modern orthodontic technologies, the clinical effectiveness and scientific justification of innovative removable expansion appliances in the treatment of malocclusion in children and adolescents require further investigation. Comprehensive evaluation of their therapeutic outcomes and functional effects is essential for optimizing orthodontic treatment protocols.

Therefore, research aimed at improving orthodontic treatment methods through the application of innovative removable expansion appliances is of considerable scientific and practical importance. The results of such studies may contribute to the advancement of orthodontic care and to the improvement of functional and aesthetic outcomes in pediatric patients with occlusal anomalies.

Goal

The aim of this study is to investigate and substantiate the effectiveness of modern methods for the correction of malocclusion in children and adolescents using innovative removable expansion appliances.

Objectives of the Study

- To analyze the prevalence and clinical characteristics of occlusal anomalies in children and adolescents. To study the morphological and functional features of the dentofacial system in patients with malocclusion.
- To evaluate the clinical effectiveness of innovative removable expansion appliances in the orthodontic treatment of occlusal anomalies. To assess the changes in the functional condition of the dentofacial system during orthodontic treatment using removable expansion appliances.
- To determine the advantages and limitations of innovative removable expanders in the correction of malocclusion in children and adolescents.
- To develop recommendations for improving orthodontic treatment methods for occlusal anomalies in pediatric patients.

Study Population (Object of the Study)

The study included 84 patients diagnosed with mesial occlusion who sought diagnostic evaluation and orthodontic treatment at the Department and Clinical Center of Orthodontics and Dental Prosthetics of the Tashkent State Dental Institute during the period from 2021 to 2025.

Subject of the Study

The research focused on the assessment of facial morphology, craniofacial relationships, and characteristics of the dentoalveolar system in patients presenting with the skeletal form of mesial occlusion. These parameters were analyzed using cephalometric radiographs, cone-beam computed tomography (CBCT), and anthropometric measurements obtained from three-dimensional (3D) virtual models of the jaws.

Clinical Assessment

The evaluation of clinical characteristics included an examination of the patient’s facial profile in both frontal and lateral views. Intraoral examination was performed to assess the condition of the teeth, dental arches, and occlusal relationships. Particular attention was also given to the examination of soft tissues of the oral cavity, including the condition of the upper and lower labial frenula, the lingual frenulum, and the periodontal status.

Photometric analysis of the face and oral cavity was carried out in frontal and lateral projections at different stages of treatment: before the initiation of orthodontic therapy, during the treatment process, and after the completion of orthodontic correction in patients with Class III malocclusion.

The study also described the conditions and procedures for conducting anthropometric measurements using plaster models and three-dimensional (3D) digital models of the jaws. These analyses included the evaluation of individual teeth, dental arch parameters, and occlusal relationships.

Furthermore, specific methods and cephalometric parameters were applied for the analysis of lateral cephalometric radiographs of patients with mesial occlusal relationships. For comparative purposes, cephalometric data from individuals with physiologically normal occlusion were also analyzed. In addition, cone-beam computed tomography (CT) images were obtained and evaluated for each participant in the main study groups as well as for individuals included in the comparison group with normal occlusion.

Before conducting the study, each patient's informed consent for examination and treatment was obtained.

Table 1.

Distribution of subjects by group.

gr	Type of anomaly	number	man	woman	Angle Class
Contr.	Physiological	9	5	5	I
1	Occlusion	20	19	11	III
2	Upper retrognathia/micrognathia	12	10	12	III
3	Lower prognathia/macrogathia	24	15	12	III
4	Combined forms	8	8	11	III
	All	10 / 73	5 / 52	5 / 51	10 / 114

To improve the diagnosis and treatment planning of dental anomalies, the Department of Orthodontics and Dental

Prosthetics at the Tashkent Dental Institute uses our patented computer program for calculating objective data on orthodontic

patients, providing comprehensive diagnostics, predicting future outcomes, and planning orthodontic treatment.

Anthropometric diagnostics performed using the software developed by the authors significantly improves the diagnostic process compared with traditional manual calculation techniques. The proposed program allows more accurate identification of transverse narrowing of the dental arches, detection of sagittal discrepancies in the anterior–posterior dimensions of the dental arches, and facilitates the development of an appropriate orthodontic treatment strategy for patients. In addition, the digital system contributes to greater economic efficiency of orthodontic care by reducing the time, effort, and financial resources required from the orthodontist during the diagnostic and treatment planning stages.

The software also provides the possibility of creating a comprehensive patient database, which enables convenient storage and retrieval of information at different stages of treatment, including the pre-treatment phase, the active treatment period, and the post-treatment stage. An additional advantage of the program is the ability to immediately generate printed reports of diagnostic calculations during the examination. Such reports may serve both as medical documentation and as legally relevant records of the diagnostic process.

A distinctive feature of the present study compared with previous investigations is the application of three-dimensional (3D) virtual models as well as 3D printed models of the jaws for both the main study group and the comparison group. Digital scanning of the dental arches was carried out using the high-speed intraoral scanner Medit i500 (manufactured in South Korea), which has a scanning field of 14×13 mm and an accuracy of approximately $2.1 \mu\text{m}$. This device allows rapid and smooth scanning and captures the natural color of dental structures without the need for powder or spray. The use of intraoral scanning technology made it possible to eliminate difficulties associated with identifying anthropometric landmarks and performing precise measurements, which are often encountered in cases of dental crowding.

The anatomical structures of the maxillofacial region were evaluated according to well-established cephalometric analyses, including those proposed by Tweed, Jarabak, Ricketts, McNamara, and Arnett. These cephalometric assessments provide detailed information not only about the static anatomical relationships within the craniofacial complex but also allow prediction of craniofacial growth patterns, planning of orthodontic appliance design, and evaluation of expected facial profile changes following orthodontic treatment.

Skeletal measurements in patients with Class III malocclusion were obtained from lateral cephalometric radiographs using methods that include multiple linear and angular parameters. The analysis revealed several characteristic skeletal relationships:

Maxillary retrognathia or maxillary micrognathia combined with a normal mandibular position and size;

Mandibular prognathism or mandibular macrognathia with a normally positioned and proportioned maxilla;

A combined skeletal pattern characterized by maxillary retrognathia or micrognathia together with mandibular prognathism or macrognathia.

Soft tissue profile characteristics were evaluated relative to the aesthetic reference line (E-line) according to the Ricketts method. In addition, superimposition of skeletal and soft tissue contours of the facial profile was performed before and after treatment using the specialized cephalometric software V-Ceph.

The results of the present study indicate that various forms of transverse narrowing of the maxilla and the upper dental arch were among the most frequently observed conditions in children and adolescents included in the study.

The measurements obtained before treatment, one month after expansion, and six months after expansion demonstrated positive changes in the position of the maxilla following orthopedic traction with a face mask in patients of Group II. The analysis showed an increase in the SNA angle, indicating forward movement of the maxilla, while the SNB angle remained relatively stable. The linear parameter A–N perpendicular also increased, reflecting improvement in the sagittal position of the maxilla, whereas the Pog–N perpendicular value showed a slight posterior shift of the mandibular point.

The data presented in Tables 1 and 2 illustrate the measurements recorded before and after the active phase of orthodontic treatment. In addition to the correction of transverse discrepancies of the dental arches, improvement in maxillary retrusion and elimination of the anterior crossbite were observed. These findings support the clinical justification for using the proposed orthodontic appliances in the corresponding age groups.

Expansion and protraction of the maxilla produced more pronounced skeletal changes in the younger patients of Group I, whose craniofacial growth had not yet been completed. In contrast, patients in Group II required more frequent appliance activation both in the transverse and sagittal directions, and the magnitude of applied force was generally greater than in the first group. Nevertheless, the overall treatment outcomes in the second group were statistically less effective, and relapse of the anomaly was observed in 6.1% of cases (7 patients).

Comparative evaluation of the measurements obtained before and after the active treatment phase confirmed that, along with the correction of transverse discrepancies, the posterior positioning of the maxilla and the associated reverse incisal overlap were successfully corrected. These clinical findings were also supported by changes in skeletal parameters revealed through three-dimensional (3D) diagnostic analyses, which further substantiated the effectiveness of the applied orthodontic appliances in patients with combined dentofacial anomalies.

Overall, the differences observed between the age groups in the degree of maxillary expansion and protraction indicate that orthodontic treatment outcomes are more pronounced in patients with incomplete skeletal growth. Greater improvements were recorded in both transverse and sagittal dimensions in the younger patient group, despite the higher frequency of appliance activation and the increased force component required in the adolescent group.

These findings suggest that patient age, which is closely related to the stage of skeletal maturation and completion of craniofacial growth, plays a crucial role in predicting orthodontic treatment outcomes and planning therapeutic strategies. Based on the results of the present study, a specialized computer program has been proposed for clinical orthodontic practice to determine the optimal width of dental arches. In addition, a newly developed removable orthodontic appliance designed for combined expansion and protraction of the maxilla has been introduced as a practical treatment model.

Conclusion

The results of this study demonstrate that the use of orthodontic appliances designed for simultaneous expansion and protraction of the maxilla is an effective method for correcting dentofacial anomalies associated with Class III malocclusion.

The conducted clinical, anthropometric, and cephalometric analyses confirmed that the application of orthopedic traction using a face mask in combination with maxillary expansion leads to significant improvement in the sagittal position of the maxilla and contributes to the normalization of occlusal relationships. The findings indicate that orthodontic treatment outcomes are strongly influenced by the patient's age and the stage of craniofacial skeletal development. More pronounced skeletal and dentoalveolar changes were observed in patients with incomplete jaw growth, demonstrating that early orthodontic intervention provides more favorable treatment results. In contrast, adolescents with more advanced skeletal maturation required stronger orthopedic forces and more frequent activation of orthodontic appliances, while the overall effectiveness of treatment was relatively lower and a small percentage of relapse cases was observed.

The use of modern diagnostic methods, including cephalometric analysis, cone-beam computed tomography, and three-dimensional digital models of the jaws, allowed for a more

comprehensive evaluation of the morphological and functional characteristics of the dentofacial system. These diagnostic approaches contributed to improved accuracy in treatment planning and monitoring of orthodontic therapy.

Furthermore, the implementation of a specialized computer program for anthropometric analysis of dental arches significantly improved the diagnostic process, facilitated the determination of optimal dental arch dimensions, and reduced the time required for orthodontic assessment. The proposed removable orthodontic appliance for combined expansion and protraction of the maxilla demonstrated clinical effectiveness and may be recommended for practical application in the treatment of dentofacial anomalies in children and adolescents.

Overall, the results of the study confirm that the integration of innovative diagnostic technologies and modern orthodontic treatment methods enhances the effectiveness of therapy and promotes stable functional and aesthetic outcomes in patients with dentofacial anomalies.

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