

# Modern methods of vertical malocclusions' treatment in the period of permanent dentition

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**Abstract:** malocclusions are the most common diseases of the maxillofacial area, which requires the special attention to the issues of their timely diagnosis, effective prevention and treatment. Vertical malocclusions in the period of permanent dentition during clinical examination are diagnosed for 21-40% of examined, and their main types – deep and open bite – significantly affect the level of dental and general health, that determines the average and high level of necessity for orthodontic treatment. The purpose of this article is to investigate scientific sources on the effectiveness of various treatment methods and methods of stabilizing the obtained results after treatment of vertical malocclusions in the period of permanent dentition over the past 10 years. 52 scientific sources from the databases Scopus, PubMed, Google Scholar were processed. Treatment of vertical malocclusions in the period of permanent dentition (especially open bite) is difficult and technological. Long-term active and retention periods are the specific features of treatment. Among the leading methods of this pathology type's treatment, myotherapeutic, appliance-based, surgical, prosthetic and complex methods are distinguished. Myofunctional therapy is aimed at restructuring pathological muscle reflexes and establishing new muscle patterns which eliminate bad habits. The strategies of open and deep bites appliance-based treatment have a number of differences. While treating open bite of adult patients, removable and non-removable appliances are used to extrude incisors, intrude molars and premolars, change the position of the lower jaw, etc.; when correcting a deep bite, the process of incisors intruding, their proclination, extruding molars is being executed, or there is a combination of these methods during treatment. High efficiency of surgical methods (orthognathic surgery, usage of microimplants, microscrews, temporary anchorage devices) in the complex treatment of vertical malocclusions in the period of permanent dentition has been established. Thus, vertical malocclusions during the period of permanent dentition are an urgent problem of modern orthodontics, that is determined the development of new accessible and effective treatment algorithms. At the same time, data on the advantages of individual treatment methods are contradictory and require further research. A perspective direction for improving treatment tactics is the study of new combined treatment methods which affect the main links of etio- and pathogenesis, that provides a long-term therapeutic effect in the future. The improvement of the process for the passive stage of orthodontic treatment must be carefully considered.

**Key words:** [Orthodontics](#), [malocclusion](#), [deep bite](#), [open bite](#), [permanent dentition](#), [treatment](#), [orthodontic appliances](#), [myofunctional therapy](#).

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## Introduction

Malocclusions are the most widely spread diseases of the maxillofacial area. The prevalence of various malocclusions during the period of permanent dentition ranges from 6-80 %, that requires special attention to timely diagnosis, proper prevention and treatment. [1-3] Vertical malocclusions in the period of permanent dentition are diagnosed during clinical examination for 21-40 % of examined, and their main types – deep bite and open bite – for 21-28 % and 3.6-10 % of examined, respectively. [1-5]

The presence and progression of vertical malocclusions significantly affect the level of dental (restriction of chewing; dysfunction of the temporomandibular joint (TMJ), masticatory and facial muscles; sleep apnea; traumatic damage of teeth and periodontal tissues; pathological tooth wearing) [6, 7] and general health (impaired speech and breathing, changes in aesthetics, impaired posture) [6, 8, 9], the process of personality formation and social status, [6,10] impaired quality of life [11], etc.

Some indices have been proposed for assessing of the morphological disorders` degree, the need for orthodontic treatment and designation of its effectiveness (TPI – Treatment Priority Index (1967), DAI – Dental Aesthetic Index (1986), PAR – the Peer Assessment Rating (1992), IOTN – Index of Orthodontic Treatment Need (1989), HLD (CalMod) – the Handicapping Labiolingual Deviation with the California Modification (1960, 1998), ICON – Index of Complexity, Outcome and Need) (Daniels C. and Richmond S.,2000)). [12-14]

Alogaibi Y.A. et al. [12] have examined 3016 people aged 14-18 years. Based on the IOTN (DHC) calculation, the average (“Moderate/borderline”) necessity for treatment of individuals with deep (n=805) and open bite (n=285) was, respectively, 27 % and 9.5 %, high need – 1.5 % and 0.7 %, respectively (P <0.001).

Ferro R. et al. [13] have examined 444 adolescents aged 14 years. One of the most frequently diagnosed types of malocclusions was deep overlap >3 mm (39%), and the average and high level of need for orthodontic treatment IOTN was, respectively, 14.7 % and 35.8 %.

During the study of orthodontic pathology manifestations among 17-21-year-old patients who didn't receive orthodontic treatment (n = 390), deep overlap >3.5 mm was detected, and the need for orthodontic treatment was 36% (ICON). [14]

The high proportion of vertical malocclusions in period of permanent dentition and the indicators of the need for orthodontic treatment of this patients group point out that the development of the new

accessible and effective algorithms for diagnosis and treatment must have been implemented. [15]

## Aim

The aim of the study is to investigate scientific data on the effectiveness of various treatment methods and methods of stabilizing the obtained results after treatment of vertical malocclusions in permanent dentition over the past 10 years.

## Materials and methods

In order to prepare this article, a systematic review of English scientific sources from Scopus, PubMed and Google Scholar databases had been conducting for the period of 2015-2025. The selection of publications was carried out in accordance with the PRISMA\*2020 (Preferred Reporting Items for Systematic reviews and Meta-Analyses). [16] (Fig. 1) The inclusion criteria were articles (meta-analyses, systematic reviews, retrospective study and randomized clinical trials) using the tags "deep bite", "open bite", "orthodontic treatment", "retention period" and patient age 12-44 years (“permanent dentition”). Exclusion criteria were articles with patients' age at the time of treatment less than 12 years, temporary or mixed dentition. 52 sources of scientific databases which are dedicated to the methods of treatment and stabilization of patients with open and deep bite in the period of permanent dentition were selected and processed.

## Review

Treatment of vertical malocclusions in the period of permanent dentition (especially open bite) is difficult and technological. Long-term active and retention periods are the specific features of open bite's treatment, as a result of which functional, morphological and aesthetic changes are achieved. [17-20] The selection of treatment protocol depends: the patient's age; the degree of formation of the dentofacial apparatus; etiology and pathogenesis, type of pathology; the presence of pathology of the function of chewing, breathing, swallowing; the general and psychological condition of the patient, individual needs and financial capabilities, etc. [19]

Among the leading methods of treatment of vertical malocclusions in the period of permanent dentition are myotherapeutic, appliance-based, surgical, prosthetic, complex, etc. [17-20]

### *Myotherapeutic method*

One of the main tasks of orthodontic treatment is the restoration and stabilization of masticatory and facial muscles myodynamic balance. [21]

Uslu O. et al. (2017) found that during the functional orthodontic treatment of patients in the prepubertal and pubertal periods in the open bite group, increased activity of the masticatory muscles and forward rotation of the lower jaw were observed;

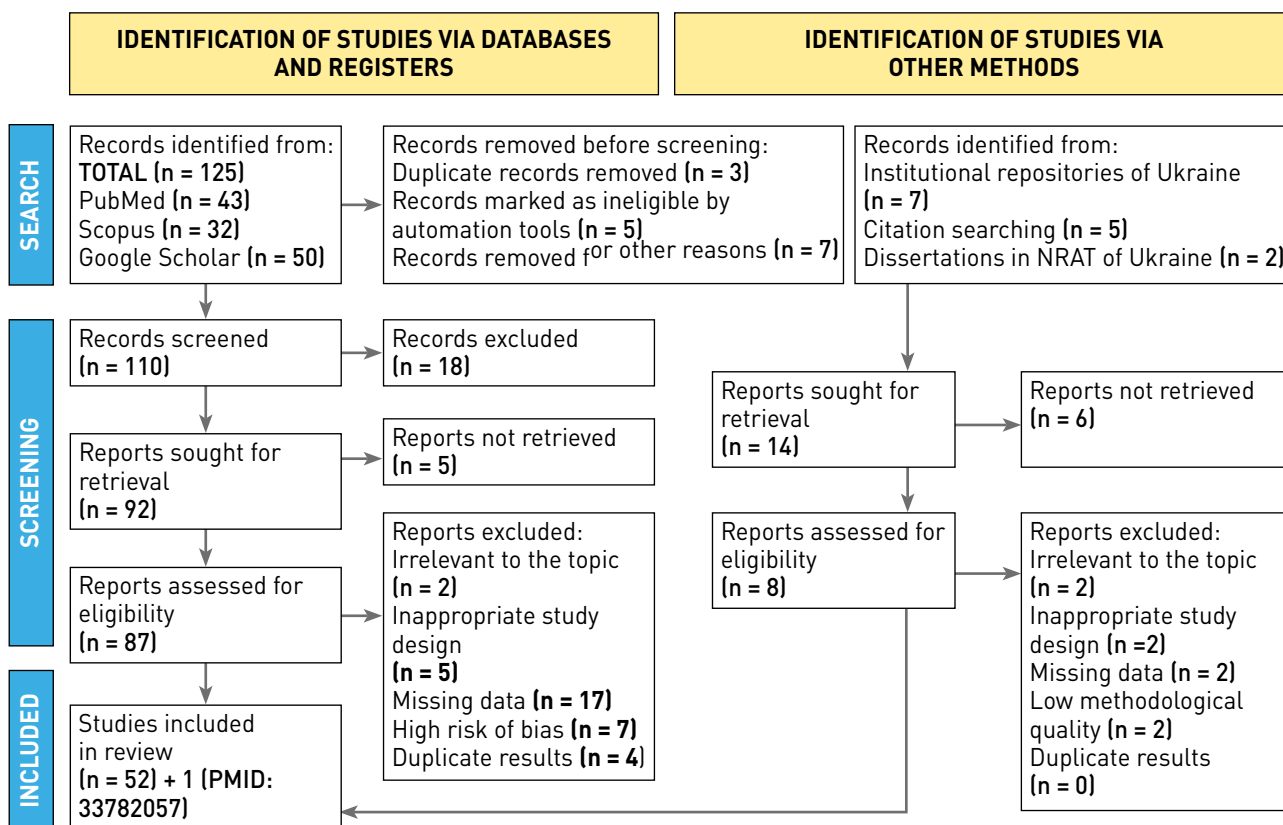


Fig. 1. Publication selection scheme according to PRISMA 2020 regarding reporting for systematic reviews and meta-analyses.

in the deep bite group, decreased activity of the masticatory muscles, posterior rotation of the lower jaw and an increase of the gonial angle were detected; muscle response to functional treatment was observed in all patients, but it was more pronounced during puberty; at least 6 months of functional treatment are required for neuromuscular adaptation. [22]

Piancino M.G. et al. (2022) have investigated the changes in the dental status of children with deep bite during the period of permanent dentition under the influence of functional orthodontic therapy (FOT, removable appliance with anterior and posterior bite plates and soft tissue retainers). It was found that the EMG-activity of the masticatory muscles had been increased at the beginning of the study, but decreased as a result of the treatment; chewing patterns showed a tendency to reduce the lateral component, which significantly increased after treatment, indicating the influence of functional therapy on the neuromuscular coordination of chewing, as well as the position of the teeth; only orthodontic treatment and correct the position of the teeth should not have been taken into account, but also combat muscle hyperactivity. [23]

A prospective direction of malocclusions treatment is the usage of myofunctional devices (elastopositioners), that, unlike functional ones, set up conditions for eliminating bad habits (including

those related to muscle function), which are the root cause of the various malocclusions development. The advantages of myofunctional devices are also such as follows: the ability to move and hold teeth in a position previously planned in the design, and due to the elasticity of the material, to make universal devices in terms of their effect on the teeth; the ability to use them without fixed orthodontic appliances for adults (if there are contraindications); better oral hygiene, etc. [24]

Orofacial myofunctional therapy (OMT) has become widespread in modern orthodontics in the complex treatment of children and adults' malocclusions. This type of therapy is aimed at restructuring pathological muscle reflexes and establishing new muscle patterns, which at the same time eliminates existing bad habits. OMT implements muscle exercises which are aimed at developing and improving the kinetic and kinesthetic organization of articulatory motor skills. [25, 26]

Smithpeter J. et al. (2010) have studied the effectiveness of orofacial myofunctional therapy comprehensive approach in combination with orthodontic treatment for the retention of open bite treatment results with adults. It was found that this approach is significantly more effective compared to orthodontic treatment ( $P < 0.0001$ ). [25]

The most common orthodontic method of treating malocclusions for adolescents and adults, including vertical ones in permanent dentition, is the **appliance-based method**.

The strategies for the appliance-based treatment of open and deep bites have a number of differences. While treating open bites for adult patients by removable and fixed appliances the extrusion of incisors, intrusion of molars and premolars, change in the position of the lower jaw, etc. are being performed; when correcting a deep bite, incisors, their proclination, molar extrusion are being intruded, or these methods are combined during treatment. [19, 27-29]

Elbarnashawy S.G. et al. (2023) have found a significantly higher effectiveness of fixed appliances and upper bite plates (UBP) combined usage for the treatment of adolescents' deep bites ( $p < 0.001$ ). The authors concluded that the main changes related to the lower jaw and included inclination and intrusion of the lower incisors along with an increase in the vertical height of the lower third of the face; the advantages of bite blocks are ease of usage and increased level of patient compliance compared to removable appliances methods. [30]

Al-Zoubi E.M. and Al-Nimri K.S. (2022) have compared the effectiveness of 0.016×0.022 nickel-titanium lower reverse arch of Spee (LRAS) and upper metal bite blocks (ABB) usage for the treatment of adults with braces deep bite. Based on cephalogram evaluation, it was found that both methods are effective; the duration of treatment with ABB was significantly shorter ( $p \leq 0.001$ ); LRAS causes proclination of the lower incisors and distal inclination of the lower molars, while ABB causes extrusion of the lower molars. [28]

The data of the study by Vela-Hernandez A. et al. (2017) demonstrates the effectiveness of the combined usage of a multibonding system and polymer blocks fixed on the upper molars during the treatment of adults' skeletal open anterior bite. Significant skeletal and dentoalveolar changes were found (molar intrusion; extrusion of the lower and upper incisors; closure of the angle of the lower jaw; reduction of the anterior facial height), a moderate tendency to relapse and long-term stability of the results were also detected. [31]

Hammad T. et al. (2023) have demonstrated the high effectiveness of extrusive arches usage for the treatment of open bite for adults. Positive incisor overlap at the end of treatment was recorded in 100% of cases. In the retention period, a combination of a fixed retainer on the lower jaw, a vacuum-formed retainer on the upper jaw and lingual spurs were used. [29]

The usage of fixed appliances with extrusive mechanics can set up the correct incisor overlap in the treatment of open bite, but it can lead to gingival enlargement and indicate a high risk of relapse. [17] Other side effects can include mesial inclination of molars and a decrease in the perimeter and length of the dental arch. [32]

The development of modern technologies has expanded the range of aligners application in the treatment of complex malocclusions, including open bite. [17, 33] Several studies indicate that the use of aligners has gained popularity among adult patients due to their higher aesthetics and comfort compared to traditional fixed orthodontic appliances. [34]

The advantage of using aligners in the treatment of open bite is the lack of extrusive effect on the distal group of teeth compared to the use of fixed appliances, the disadvantage is the possibility of lateral teeth intrusion due to the thickness of the plastic and the action of the masticatory muscles. [35]

The usage of aligners helps to correct the impact of harmful habits, such as tongue thrusting, in the treatment of patients with moderate to severe level of anterior open bite due to the presence of the anterior teeth plastic covering. [36]

The data of Khosravi R. et al. (2017) indicates the possibility of using aligners to control the vertical dimension in the treatment of deep and open bite. The main mechanism of open bite correction is extrusion of the incisors with an average value of 1.5 mm. [37]

Moshiri S. et al. (2017) have found that the correction of open bite in the treatment of aligners mainly occurred through counterclockwise rotation of the lower jaw as a result of the lower molars intrusion. [38]

Harris K. et al. (2020) have detected a reliable effectiveness of open bite treatment with aligners in a group of adult patients ( $p < 0.05$ ). The result was achieved by extrusion of the incisors and intrusion of the maxillary and mandibular molars with slight autorotation of the mandible. [33]

The data of Suh H. et al. (2023) indicates the successful treatment of adult patients with aligners alone. During the studied retention period ( $2.1 \pm 1.1$  years), no significant difference in effectiveness between fixed retainers and vacuum retainers in both jaws ( $p > 0.05$ ) was found. [35]

Alawdi G.M. et al. (2024) indicates the inconsistency of data on the mechanisms of open bite correction in aligner treatment for adults. [34]

While comparing the effectiveness of aligners and fixed appliances (in combination with tooth extraction and usage of microimplants) in the treatment of open bite for adult patients with hyperdivergent growth

pattern, Garnett B.S. et al. (2019) found no significant difference in cephalometric analysis between groups ( $p > 0.05$ ). [39]

Steele B.P. et al. (2022) have compared the effectiveness of open bite treatment for adult patients with aligners and a multibonding system in combination with miniplates for distal intrusion (MDI). Based on the analysis of lateral cephalometric data, the authors concluded that both methods are effective in the treatment of open bite and the prevention of post-treatment deep overlap. When using aligners, occlusion correction was performed by extrusion of the maxillary and mandibular incisors, while when using MDI, molar intrusion and counterclockwise mandibular autorotation were performed. [40].

Similar results were obtained by Chamberland S. et al. (2024) when comparing the therapeutic efficacy of aligners and fixed appliances and skeletal temporary anchorage devices (TAD) in adults with open bite. [41].

**Surgical methods**, including orthognathic surgery, are effective in treating the skeletal form of open bite, which is a consequence of excessive vertical facial growth. [17, 42]

Studies by Todoki L.S. et al. (2020) indicate a statistically higher effectiveness of orthognathic surgery compared to aligners, fixed appliances, and TAD in the treatment of open bite for adults. [17]

However, the vast majority of such patients does not agree to any surgical manipulation, preferring orthodontic, i.e. equipmental treatment, which significantly prolongs the time, treatment options and predictability of results. [43]

Recently, the usage of microimplants or miniscrews (miniplates) among other surgical methods in the complex treatment of vertical malocclusions in permanent dentition has shown high efficiency [42, 44].

The usage of TAD facilitates tooth movement by eliminating the plasticity factor, provides continuous force transmission and absolute fixation of teeth, faster functional adaptation of muscles and TMJ, compared to orthognathic surgery [45].

In contrast to numerous studies proving the effectiveness of various devices and technologies for the intrusion of permanent molars, there are publications indicating limited evidence of these studies, given the unclear long-term stability of results, cases of complications, etc. [42, 45]

Orthognathic surgery for correcting of an anterior open bite involves performing a LeFort I osteotomy and, in some cases, a mandibular ramus osteotomy or molar (premolar) extraction, which displaces the

maxilla and allows the counterclockwise rotation of the mandible. [46]

Foosiri P. et al. (2019) have evaluated the scientific sources from the point of view of open bite treatment stability using extraction and non-extraction techniques for permanent dentition. The average stability rates were 94% and 74% for extraction and non-extraction, respectively. The results showed no significant changes in cases of extraction (mean difference (MD) 0.49, 95% CI  $-0.18-1.16$ ;  $P = 0.15$ ), but showed a significant change in cases of no extraction (MD 1.12, 95% CI  $0.77-1.46$ );  $P < 0.00001$ ). [47]

After the active phase of treatment is completed, an important task is the maintenance (**retention**) of the achieved result. [19, 48]

One of the main tasks of the retention period, along with the retention of the dentition, is to ensure a status of myofunctional equilibrium, which can be achieved by balancing the external (facial muscles and muscles of the lips and cheeks) and internal (muscles of the tongue, floor of the mouth, soft palate and posterior pharyngeal wall) muscle action. [49]

A retrospective review of stability treatment outcomes` studies concerning vertical malocclusions for adults over the past 25 years has shown that open bite recurrences are occurred in 15–44 % of cases within the period of 2–5 years after the end of active treatment. [18, 50]

Proffit W.R. et al. [51] have proposed an evaluation scale for the stability of open bite treatment outcomes, based on the percentage of patients with significant signs of recurrence. “Highly stable” results can be considered when significant signs of recurrence ( $> 2$  mm) are observed in less than 10% of patients, “stable” –  $< 20\%$ , and very significant signs of recurrence ( $> 4$  mm) are not observed at all.

Given the high probability of recurrence after treatment (especially open bite) for adults, Greenlee G.M. et al. (2011) conducted a meta-analysis of surgical and orthodontic methods stability for treating adults` open bite. The authors concluded that both groups of methods are effective (result stability  $> 75\%$ ). [18]

Salehi R. et al. (2015) have indicated the absence of a significant difference in the treatment results of adult patients group with open bite after tooth extraction and without tooth extraction ( $p = 0.117$ ) and depending on the type of retention device ( $p = 0.801$ ). After 3 years of retention period, relapse was diagnosed for 17 % of patients, even with the presence of fixed retainers. In order to prevent relapse, the combined usage of retainers` different types together with those fixed on the teeth is recommended. [52]

For stable and long-term maintenance of open bite treatment results, there are a considerable number of removable (Hawley appliances, elastic retainers) and non-removable retention devices. [51, 53]

### Discussion

The analysis of modern scientific sources confirms the high level of interest regarding the problem of treating deep and open bite in the period of permanent dentition.

The main method of selection remains the appliance-based method using fixed appliances. The advantages of this method are relative accessibility, predictability of the result, convenience at work for the doctor, the possibility of changing treatment tactics, disadvantages – low aesthetics, a number of inconveniences for the patient (complication of individual hygienic care of the oral cavity, traumatization of the oral mucosa, frequent visits to the doctor, dietary restrictions), high probability of debonding.

A modern alternative to multibonding appliances are aligners. In addition to the above-mentioned features of aligners, their advantages include the absence of dietary restrictions and a lower frequency of visits to the doctor, and among the disadvantages are the high cost, the likelihood of deviation from the treatment plan due to the patient's failure to comply with the mouthguard wearing regimen, the likelihood of a greenhouse effect, which can lead to a deterioration in oral hygiene and increase the risk of damage to the hard tissues of the teeth and gums.

Considering the contradictory results when comparing the effectiveness of the use of multibonding appliances and aligners for the treatment of vertical malocclusions in the period of permanent dentition, further study of their effectiveness, especially taking

into account long-term results, may be a relevant task of modern orthodontics.

Increasing the effectiveness of treatment, especially in cases of medium and high complexity, can be achieved only by combining several treatment methods and a multidisciplinary approach. The most common direction is the combination of appliance-based and surgical treatment methods, especially for the treatment of skeletal forms of open and deep bites. The additional use of temporary anchorage devices or tooth extraction allows the orthodontist more easily and accurately predict and implement treatment.

Considering the advantages of the etiopathogenetic influence of myofunctional methods for ensuring the state of myofunctional balance of the masticatory and facial muscles, it is highly perspective to further study their effectiveness in complex treatment both during the use of multibonding appliances and in the retention period with the assessment of long-term results.

### Conclusions

Vertical malocclusions during the period of permanent dentition are an urgent problems of modern orthodontics, which determined the strong necessity of development of new accessible and effective treatment algorithms. In orthodontic practice, various methods are used to treat vertical malocclusions in permanent dentition. At the same time, data on the advantages of individual treatment methods are contradictory and require further research. A perspective direction for improving treatment tactics is the study of new combined treatment methods that affect the main links of etio- and pathogenesis, which provides a long-term therapeutic effect in the future. Special attention must be paid to the process of the orthodontic treatment passive stage improvement.

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## Сучасні методи лікування вертикальних зубощелепних аномалій в постійному періоді прикусу (огляд літератури)

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**Анотація:** зубощелепні аномалії є одними з найбільш розповсюджених захворювань щелепно-лицевої ділянки, що потребує підвищеної уваги до питань їх своєчасної діагностики, ефективних профілактики та лікування. Вертикальні зубощелепні аномалії в період постійного прикусу під час клінічного огляду діагностуються в 21-40 % обстежених, а їх основні види – глибокий прикус і відкритий прикус – значно впливають на рівень стоматологічного та загального здоров'я, що зумовлює середній та високий рівень потреби в ортодонтичному лікуванні. Метою проведення даного дослідження було вивчення літературні дані за період 2015-2025 рр. щодо методів лікування та ретенції результатів лікування вертикальних зубощелепних аномалій в постійному періоді прикусу. Було відібрано та опрацьовано 52 джерела літератури баз даних Scopus, PubMed, Google Scholar. Лікування вертикальних зубощелепних аномалій в постійному періоді прикусу (особливо відкритого прикусу) є складним та технологічним. Особливостями лікування є довготривалі активний та ретенційний періоди. Серед провідних методів лікування даного виду патології виділяють міотерапевтичний, апаратний, хірургічний, протетичний та комплексний методи. Міофункціональна терапія спрямована на перебудову патологічних м'язових рефлексів та встановлення нових м'язових патернів, які усувають шкідливі звички. Стратегії апаратного лікування відкритого та глибокого прикусів мають ряд відмінностей. При лікуванні відкритого прикусу у дорослих пацієнтів знімною та незнімною апаратурою проводять екструзію різців, інтрузію молярів та премолярів, зміну положення нижньої щелепи тощо; при корекції глибокого прикусу – інтрузію різців, їх проклінацію, екструзію молярів або комбінують дані методи під час лікування. Встановлена висока ефективність хірургічних методів (ортогнатохірургія, застосування мікроімплантів, мікрогвинтів, пристроїв тимчасового кріплення) при комплексному лікуванні вертикальних зубощелепних аномалій в постійному періоді прикусу. Отже, вертикальні зубощелепні аномалії в період постійного прикусу є актуальною проблемою сучасної ортодонції, що зумовлює необхідність розробки нових доступних та ефективних алгоритмів лікування. Водночас дані щодо переваги окремих методів лікування є протилежними та потребують подальшого дослідження. Перспективним напрямком вдосконалення лікувальної тактики є вивчення нових комбінованих методів лікування, які впливають на основні ланки етіо- та патогенезу, що забезпечує в майбутньому тривалий лікувальний ефект. Особливої уваги потребує вдосконалення процесу пасивного етапу ортодонтичного лікування.

**Ключові слова:** ортодонція, зубощелепні аномалії, глибокий прикус, відкритий прикус, постійний прикус, лікування, ортодонтична апаратура, міофункціональна терапія



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