

Research Progress on Early Orthodontic Treatment Based on Occlusal Guidance

Xi Liu¹, Jie Deng^{2,*}

¹Department of Stomatology, Affiliated Qujing Hospital of Kunming Medical University, Qujing, China

²Department of Orthodontics, Nanjing Stomatological Hospital, Medical School of Nanjing University, Nanjing, China

Email address:

jie.deng917@gmail.com (Jie Deng)

*Corresponding author

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Abstract: Early orthodontic treatment based on occlusal guidance is an important aspect of dental care that focuses on improving the growth and development of the craniofacial region in children. This approach has been shown to be effective in reducing the occurrence and severity of malocclusion, which can have negative impacts on both physical and mental health. However, early orthodontic treatment based on occlusal guidance is not without its challenges. The process requires careful consideration of various factors, including the unpredictability of growth and development during childhood and adolescence. Furthermore, the transition from primary to permanent teeth presents unique challenges that require the integration and collaboration of multiple dental disciplines, including orthodontics, restorative dentistry, endodontics, and prevention. Despite the challenges, early orthodontic treatment based on occlusal guidance remains an essential aspect of dental care for children. To ensure that the best outcomes are achieved, it is important to select the right timing and treatment methods that are tailored to each child's unique needs. This can be challenging due to the absence of a universal strategy for selecting treatment options. In light of this, this article provides guidance on the timing and selection of orthodontic treatment methods based on different stages of growth and development. By conducting a systematic review of the occlusal guidance management system, this article can assist clinicians in providing multidimensional prevention and early orthodontic treatment of malocclusion.

Keywords: Growth and Development, Occlusal Guidance, Malocclusion, Early Orthodontic Treatment, Prevention

1. Introduction

Pediatric malocclusion is reported as one of the three major oral diseases by the World Health Organization (WHO). With a global incidence rate of almost 60%, it affects the dentofacial functions, facial aesthetics, as well as the growth and development of nearly 260 million Chinese children, and has an adverse impact on their overall physical and mental health. [1] As a result, an increasing number of parents are seeking medical advice and early intervention for their children. Malocclusion is caused by a combination of genetic and environmental factors. Fortunately, early orthodontic treatment under the occlusal guidance management system can provide a favorable environment for craniofacial growth and development, correcting abnormal dental and facial growth, and even controlling genetic factors. This approach

not only effectively reduces the incidence of pediatric malocclusion but also improves the physical and mental well-being of children throughout the country, making it an urgent need for China's social and economic development.

Occlusal guidance is a clinical approach that utilizes the plasticity of jawbone development in early stages, takes advantage of physiological forces during tooth eruption, and combines prevention, interception, and orthodontic treatment methods to establish a proper occlusal relationship of the permanent dentition during craniofacial growth and development in children. [2] In its broad sense, occlusal guidance encompasses not only the early treatment of malocclusion and breaking harmful oral habits, but also all the methods and measures that promote the smooth replacement of primary teeth and healthy development of permanent teeth into normal occlusion, including preventing and treating dental caries, as well as pulp and periapical diseases in

primary teeth. [3] Most of the clinical management of pediatric stomatology falls under the scope of occlusive guidance, which involves actively treating endodontic diseases in primary teeth during the transition from primary to permanent dentition. This approach can help preserve the integrity of the primary dentition, maintain the length of the dental arch, and prevent loss of space for permanent teeth eruption, which can easily lead to the occurrence or worsening of malocclusion. [4]

Early orthodontic treatment based on occlusive guidance aims to correct malocclusions that arise in children during the primary or mixed dentition stages as a result of environmental factors. Through a combination of preventive, interceptive, and corrective measures, the causative factors of malocclusion are addressed as early as possible, promoting normal maxillofacial growth and development in children. This

approach can reduce the incidence and severity of pediatric malocclusion and facilitate a smooth transition from primary to permanent teeth, leading to the establishment of a favorable occlusion that promotes dental and craniofacial growth and development, thus helping to improve the physical and psychological well-being of children.

Each stage of occlusal development is unique and has its own distinct features. Table 1 illustrates the different stages of occlusal development and provides a summary of their characteristics. This article employs the different stages of occlusal development as a framework to review the oral conditions that children may encounter throughout their growth and development. It recommends the most appropriate treatment methods for the reference of clinicians, providing them with effective diagnostic and treatment strategies.

Table 1. Different stages of occlusal development.

| Development Stage | Age Range | Description |
|-------------------|-----------------|---|
| Stage 1 | 0.5-2 years old | Primary dentition and occlusion establishment stage |
| Stage 2 | 2-3 years old | Early primary dentition stage |
| Stage 3 | 3-6 years old | Primary dentition stage |
| Stage 4 | 6-8 years old | Incisor replacement stage |
| Stage 5 | 9-11 years old | Lateral teeth (canine and premolar) replacement stage |
| Stage 6 | 12-15 years old | Permanent dentition and occlusion establishment stage |

2. Primary Dentition and Occlusion Establishment Stage

In the course of primary dentition development, young children may exhibit some oral habits such as tongue protrusion or finger sucking. While these habits may initially be considered as normal psychological needs, they should be closely monitored. If such habits persist for a long time, they can lead to the development of stubborn habits that can negatively impact the primary teeth development in children. When these habits reach a certain intensity and frequency, they can hinder the normal growth and development of oral and maxillofacial structures, leading to malocclusion. [5] At this stage, although it may be difficult for young children to cooperate with orthodontic treatment, passive intervention such as finger guards can be used to break the habit.

In addition, it is crucial to take preventative measures during the breastfeeding period, including adopting proper breastfeeding practices to prevent compensatory mandibular protrusion and functional crossbite. It is also important to maintain a proper sleeping position to prevent prolonged head tilt, which may impact the normal growth of craniofacial structures.

3. Early Primary Dentition Stage

3.1. Dental Caries

The prevention and control of dental caries is essential for oral health care during the primary dentition stage. This is

especially important since caries in the upper and lower anterior primary teeth can narrow the tooth crown and shorten the dental arch, which may affect the eruption pathway of permanent teeth.

3.2. Injury to Primary Anterior Teeth

Prevention of injury to primary anterior teeth is also crucial during this stage. Toddlers are learning to walk and are prone to accidental falls, which can result in injury to primary anterior teeth. Such injuries can impact the development of permanent teeth and cause masticatory dysfunction as well as functional crossbite in the anterior teeth.

3.3. Poor Oral Habits

After the primary teeth have fully erupted, the maxillofacial region enters the second period of rapid growth and development. If a child has long-term poor oral habits, it can lead to malocclusion. [6] The occurrence and severity of malocclusion are related to the frequency, duration, and intensity of these poor habits. Doctors should determine if the child's poor oral habits have persisted for a long enough period and whether there is a genetic factor associated with malocclusion during the primary dentition stage before making an accurate differential diagnosis and determining whether intervention is necessary. [7] However, at this stage, the child may not be old enough to comply with functional orthodontic treatment. Therefore, recommended treatment options include finger guards and passive interception by parents.

4. Primary Dentition Stage

At this stage, the primary dentition is fully developed, and common malocclusions may include anterior deep overbite, anterior crossbite, posterior crossbite, anterior open bite, dental arch constriction, mandibular retrusion, and primary teeth crowding. The effectiveness of any treatment largely depends on the patient's compliance, and experimental intervention is typically initiated after the child has started receiving early childhood education. [8]

4.1. Simple Protrusion of the Primary Maxillary Incisors

The condition can be treated by retracting the anterior teeth within the arch using a maxillary dual coil labial archwire, which not only meets the aesthetic expectations of parents, but also helps prevent fractures of the primary incisors caused by external trauma [9].

4.2. Deep Overbite of Primary Anterior Teeth

When a deep overbite of Class III or higher is present and the lower anterior teeth bite into the maxillary palatal mucosa, causing symptoms such as mucosal injury and pain, orthodontic treatment is necessary. The goal of treatment is to eliminate functional factors and prevent long-term irritation of the palatal mucosa by the lower anterior teeth. For a thorough correction of deep overbite, it's best to wait until the early permanent dentition stage and formulate a treatment plan through careful analysis. For the correction of a deep overbite, a maxillary bite plate can be used as a treatment appliance. If there is an anterior teeth lingual inclination, a combination of a maxillary bite plate and a maxillary dual coil lingual spring can be used to open the bite while adjusting the axial inclination of the anterior teeth.

4.3. Functional Anterior Deep Overbite in the Primary Dentition Stage

Functional anterior deep overbite is often caused by insufficient width between the maxillary canines, resulting in a retruded mandible. Prompt treatment is recommended for this type of functional deep overbite. The treatment of choice is a maxillary arch expander that widens the space between the maxillary canines, coordinates the shape of the upper and lower dental arches, and guides the mandible forward. The orthodontic appliance of choice is the helix expander. It is important to note that the arch expansion spring should be placed between the primary canines during the design and fabrication of the appliance to expand the anterior segment of the primary arch. In addition, a maxillary incline plane can be used in combination to guide the mandible forward to the normal occlusal position.

4.4. Anterior Deep Overbite Resulting from Abnormal Maxillary and Mandibular Bone Structure

Typically, this condition is not treated as it is often associated with craniofacial growth patterns. Early treatment has limited inducing effects on jaw bone growth, and patients

treated for this condition are susceptible to relapse during the adolescent growth period. [10]

4.5. Anterior Crossbite of Primary Teeth

Anterior crossbite of primary teeth can occur due to various reasons, such as upright upper front teeth with functional mandibular protrusion, insufficient wear of lower canines, canine occlusal interference, and unilateral anterior crossbite. Before orthodontic treatment, a thorough clinical examination should be conducted to identify the cause of the condition. Treatment may involve adjusting the occlusion by grinding down interfering primary teeth, correcting the position of anterior teeth, and addressing functional mandibular protrusion or deviation. After the correction of anterior crossbite, it's important to check for any remaining occlusal interference and advise parents to monitor the child's habit of mandibular protrusion with regular follow-up visits. Orthodontic appliances commonly used to treat anterior crossbite include maxillary block appliance, mandibular bonded incline plane, and fixed maxillary appliances. [11]

4.6. Posterior Crossbite of Primary Teeth

This is mostly caused by narrow maxillary posterior dental arches, leading to unilateral or bilateral posterior crossbite. The treatment involves using either removable or fixed maxillary arch expansion appliance.

4.7. Functional Anterior Open Bite of Primary Teeth

Habits such as mouth breathing, thumb-sucking, lip-biting, and tongue-thrusting are important factors that lead to the development of malocclusion. The abnormal pressure they cause can disrupt the muscle balance of the oral and maxillofacial system, interfering with its normal development. Early detection and elimination of harmful oral habits is key to preventing malocclusion. [12] The treatment of functional anterior open bite should also focus on the psychological state of young children and identify any underlying factors that may contribute to their poor oral habits. Treatment options may include the use of lip bumper or cheek shields to break thumb-sucking, lip-biting habits, or cheek-biting habits; teaching children proper swallowing methods and, if possible, using appliances such as tongue crib or palatal screen to correct tongue-thrusting and tongue-protruding habits, which can prevent anterior dental protrusion and open bite. Screening and treating respiratory disorders that obstruct normal breathing can also be helpful in breaking the habit of mouth breathing. If a child already exhibits dental protrusion and lip laxity due to mouth breathing, corrective measures such as mouth breathing patches can be used while maintaining unobstructed airways. [13] The MRC Muscle Functional Orthopedic Device has also been proven effective for correcting poor oral habits, and children are generally receptive to this type of treatment. [14]

4.8. Pathologic Anterior Open Bite

This is often caused by obstruction of the nasopharyngeal

airway. To address this condition, in addition to guiding children to actively treat the underlying disease, obstructive devices such as anterior vestibular shields, palatal bar, palatal crib, and reverse labial archwire can be used to correct secondary habits including mouth breathing, thumb sucking, tongue thrusting, and lip biting. Clinical practitioners should screen for abnormal tongue position during speech and conduct special speech tests. If there are also indications of unilateral chewing and postural abnormalities, the root causes of the condition should be addressed, and parents should be informed of active guidance and monitoring to prevent more severe malocclusions. For some children who retain infantile tongue thrusting and swallowing habits, this cannot be considered the sole cause of anterior open bite. It is necessary to observe whether the child can transition to mature swallowing habits after the age of 6. [15]

4.9. Crowding of Primary Dentition

This condition generally does not require special treatment. However, it is important to maintain good oral hygiene in young children with crowded teeth, with the help of flossing to clean interdental spaces. Otherwise, neighboring tooth decay and gingivitis are likely to occur, which can further aggravate the crowding. In children with more severe crowding during the early stage of mixed dentition, extraction is often required for orthodontic treatment during the permanent dentition stage. A systematic fixed orthodontic treatment plan can be determined after cephalometric analysis and growth evaluation during the late mixed dentition or early permanent dentition stages. [16]

4.10. Syndromes Associated with Facial Developmental Disorders

There are several syndromes associated with facial developmental disorders that present with visible facial abnormalities, including the “first and second branchial arch syndrome” [17], “Treacher Collins syndrome” [18], “Crouzon syndrome” [19], “Apert syndrome” [20], and “Binder’s syndrome” [21], among others. Some patients may present with unattractive facial appearance, mandibular retrusion, or anterior crossbite, while others may present with crossbite due to acrocephaly and midface dysplasia. These syndromes require a multidisciplinary approach involving consultation with a surgeon to create a comprehensive treatment plan, with careful consideration given to supporting measures for early orthodontic treatment.

5. Incisor Replacement Stage

During this stage, the upper and lower incisors as well as the first permanent molars begin to erupt. Clinical practitioners should pay attention to and address problems associated with dental malocclusion, such as irregular eruption and alignment of anterior teeth, crowding or spacing of anterior teeth, anterior crossbite, individual tooth crossbite, open bite, deep overbite, rotated permanent teeth, retained

primary teeth, delayed eruption of permanent teeth, diastema between central incisors, and ectopic eruption of the first permanent molar and anterior teeth. [22]

5.1. Individual Anterior Crossbite

This condition requires active treatment, otherwise it may cause displacement of the lower anterior teeth to the lip side, as well as resorption of the gums and alveolar bone. The treatment can involve the use of maxillary block appliance and individual tooth coil spring. The dual coil labial archwire can be used in combination to ensure proper alignment of the anterior teeth.

5.2. Individual Posterior Crossbite

The first permanent molars usually erupt at almost the same time as the anterior teeth. If individual posterior tooth crossbite, especially involving the first molars, is found during clinical examination, it should be treated promptly. Treatment options may include fixed inter-arch traction of individual teeth or orthodontic treatment with a unilateral block appliance. After addressing the malocclusion of the individual tooth, an observation period is recommended before conducting a systematic analysis upon completion of the transition of the remaining teeth.

5.3. Unilateral and Bilateral Posterior Crossbite

If a posterior crossbite is present, whether it is unilateral or bilateral, it is advisable to treat it while the posterior segment is still at the primary dentition phase. This is due to the fact that during the early mixed dentition phase, the mid-palatal suture can be expanded to the maximum extent possible. [23] Treatment options may include active helix expander or fixed expander. After the treatment of posterior crossbite, an observation period is recommended with regular follow-up checks to ensure the proper eruption of permanent teeth and the establishment of appropriate occlusion.

5.4. Deep Overbite and Open Bite Caused by Dental Factors

It is important to first assess for any harmful primary habits and rule out the presence of extra teeth. In the case of dental diastema due to anterior tooth inclination, active or locally fixed correction devices can be used to retract the anterior teeth and close the gaps. The primary treatment goal for early correction measures should be to break harmful oral habits. For gaps that occur due to discrepancies between tooth mass and bone mass, a comprehensive analysis and treatment plan should be developed during the early permanent dentition stage. [24]

5.5. Diastema Between the Upper Central Incisors

The presence of diastema between the upper central incisors during tooth eruption is a common occurrence, typically caused by the pressure of dental germ of lateral incisors on the roots of the central incisors. In most cases, the diastema will close on its own once the lateral incisors have erupted, without

the need for any special treatment. However, clinicians should be mindful of potential complicating factors such as the presence of a deep and attached upper labial frenum or the possibility of extra teeth between the central incisors. In such cases, it is recommended to consult with an oral and maxillofacial surgeon to jointly develop a treatment plan before proceeding with any treatment.

5.6. Dental Misalignment or Crowding

The treatment of dental misalignment or crowding during the mixed dentition period can be complex, with various stages and limitations. However, most experts believe that early intervention and treatment of crowding can be highly beneficial. First, it is necessary to distinguish the condition from temporary crowding during the mixed dentition period. Temporary crowding during the mixed dentition period refers to crowding that occurs within 1.5 mm between the lower incisors when they erupt. As the lower front teeth tilt forward, the canine teeth shift into place and the space between them widens, the crowding typically resolves on its own without any special clinical treatment. It is only when the residual space generated by jaw development and tooth replacement can not compensate for the crowding of the anterior teeth can it be diagnosed as Angle's Class I malocclusion. [25]

i. Mild to moderate dental misalignment and crowding: Mild crowding during the mixed dentition period typically manifests as crowding of the lower anterior teeth. For patients with lower anterior teeth crowding during the mixed dentition period, early intervention is suggested to prevent potential negative impacts on dental arches, including shortening and narrowing of basal bone arch and occlusal trauma caused by crowding. [26] Treatment methods: 1) Interproximal enamel reduction: In the mixed dentition period, mild crowding in the anterior teeth can be improved through primary canine reduction. 2) Distalization of molars: The ideal timing for distalization is during the mixed dentition or early permanent dentition period. Orthodontic devices such as lip bumpers or facebow can be used to improve mild to moderate crowding. The first molars are moved distally and repositioned, increasing the length of the dental arch and resolving the crowding. There are various treatment methods for distalizing molars, including the active pendulum appliance, Nance appliance and helical coil spring, fixed sectional arch with helix expander, and J-hook headgear. 3) Arch expansion involves using a helix expander to apply orthodontic forces to the alveolar and basal bone. This approach is quite effectively in increasing the arch width. [27] In the mixed dentition period, the intercanine and interalveolar width continue to actively increase with the eruption of incisors. This would lead to a further increase in the expansion force, which can effectively alleviate anterior crowding in both maxillary and mandibular teeth. [28]

ii. Severe dental misalignment and crowding: In general, it is recommended to undergo comprehensive fixed orthodontic treatment after the permanent dentition occlusion has been established. The primary focus of clinical treatment is to address any bite trauma caused by crowding. Sequential tooth

extraction can also be considered to alleviate crowding during the mixed dentition period. Once the teeth are replaced, a systematic analysis can be performed, and if necessary, additional tooth extraction can be performed to align the teeth properly. A case-control study has shown that in Angle's Class I patients around the age of 11 with severe crowding, removing the maxillary first premolars can effectively relieve anterior crowding, and the stability of anterior alignment is maintained in adulthood. [29]

5.7. Ectopic Eruption of the First Permanent Molars

When the first permanent molars erupt in a position that is too close to the midline, it can cause resorption of the roots of the second primary molars. Ectopic eruption of the first permanent molars often results in loss of space and a decrease in the arch length. In severe cases, it can even cause early loss of the second primary molars. This condition can be reversible or irreversible and requires active treatment. Common clinical methods include the use of orthodontic separators, modified Nance appliance, and modified lingual arch appliance [30].

6. Lateral Teeth Replacement Stage

During this stage, the primary canines, as well as the first and second primary molars, are replaced by permanent teeth. This can lead to common conditions such as early loss of primary molars, early eruption of permanent teeth, and ectopic eruption of permanent teeth.

6.1. Early Loss of Primary Molars

It is important to maintain and restore the spaces left by the lost primary molars during this period, as it is a high-risk age for early loss of primary teeth. If primary molars are lost prematurely while spaces are still open, it is crucial to maintain the spaces until the permanent teeth emerge. This helps to prevent dental crowding and ectopic eruption of the permanent teeth, while also preserving a stable occlusion. [31] This is usually achieved with the use of fixed space maintainer. 1) If a single primary molar is lost prematurely, a fixed wire space maintainer can be used. 2) If one primary molar is lost on each side or if two primary molars are lost on the same side, a mandibular lingual arch or maxillary Nance appliance space maintainer can be used. 3) If the primary canines are lost prematurely while spaces are still open, it is important to maintain the space and, if necessary, extract the corresponding contralateral primary canine to prevent midline deviation. A palatal or lingual arch should also be used to stabilize the position of the anterior teeth and prevent lingual tipping or distalization that could affect the length of the dental arch. [32]

6.2. Early Loss of Primary Teeth

Long-term premature loss of primary teeth leading to space loss is currently the most common clinical problem in pediatric dentistry. In such cases, it is necessary to restore the lost spaces. [24] There are several ways to accomplish this: 1) For space loss within 3mm, a space maintainer can be used to

prevent further drifting of teeth. Lip bumpers, active or fixed appliances can also be used to move posterior teeth distally and restore the lost space. [22] 2) When the space loss is greater than 3mm, a local helical coil spring can be used to open the space if the spring of an active orthodontic appliance cannot be placed in the gap. 3) In cases of severe anterior movement of permanent molars, implant anchorage can be used for distalization and repositioning. Unilateral or bilateral facebow can also be used to move molars posteriorly.

6.3. Retained Primary Teeth and Ectopic Eruption of Permanent Teeth

Retained primary teeth refer to the primary teeth that have not fallen out on time despite permanent teeth having erupted, or primary teeth that are retained in permanent dentition because the permanent teeth have not erupted. [2] On the other hand, ectopic eruption of permanent teeth refers to teeth that deviate from their normal position during eruption or do not erupt in their normal position in the dental arch, with common examples being ectopic canines and first molars. Throughout the long evolutionary history of humans, the refinement of our food has led to the weakening of chewing organs, resulting in the discrepancy of tooth mass and bone mass. Today, more and more children are present with retained primary incisors and ectopic eruption of permanent incisors. Melo [33] conducted a comparison between the primary dentition of children 50 years ago and those of today and found that the primary dentition of children today is more crowded, and these conditions occur more frequently. [34] If ectopic teeth are detected early on, they can be corrected using fixed or active appliances to change their eruption direction. For fully ectopic teeth, orthodontic treatment can be used clinically to move them to the nearest dental arch position while preserving their original position, and then adjust their appearance in the later stages of treatment while ensuring a stable occlusion.

6.4. Ectopic Eruption of First and Second Premolars

The ectopic eruption of first and second premolars is different from that of primary lower incisors, permanent canines, and first molars. The retention of primary molars is often caused by chronic apical periodontitis, which can lead to the damage of periodontal tissues around the root of the primary tooth. In severe cases, it can even damage the developing permanent tooth germ, causing the first and second premolars to erupt from the buccal or palatal side of the dental arch. Oral examination by a dentist can identify and timely remove primary molars with apical periodontitis, providing a pathway for the eruption of permanent teeth. [22]

6.5. Impacted Eruption of Permanent Canine

Impacted eruption of permanent canine is more commonly found in the maxillary canines. If a child's primary canine has not loosened or is not palpable on the inside of the lip by the age of 8-9 years old, it is recommended to perform an X-ray examination to determine the presence of an ectopic permanent canine. [35] When the ectopic canine is tilted

forward, it can cause resorption of adjacent lateral incisors or lip inclination of the tooth crown. Research has shown that if the overlapping of the tilted permanent canine and lateral incisor root is less than 50%, removing the primary canine can effectively adjust the eruption of the permanent canine in 91% of cases. However, if the overlap is greater than 50%, early removal of the primary canine can still achieve self-adjustment of the permanent canine in 64% of cases. [36] If the opportunity for early intervention is missed, the ectopic canine can cause compression of the adjacent teeth roots, horizontal impaction of the maxillary canine, or ectopic maxillary canine in the position of the maxillary first premolar. Treatment of these conditions requires complex anchorage design and longer timeframe. It is advisable to wait until the transition from primary to permanent dentition is complete, conduct a comprehensive analysis of the case, and employ orthodontic traction to guide the proper eruption of the impacted canine.

7. Permanent Dentition and Occlusion Establishment Stage

Also known as the early permanent dentition stage, this is a transitional phase during which the permanent teeth develop and establish proper occlusion. Generally, the period after the eruption of the second molars, between the ages of 12-15, is called the early stage of permanent dentition. By this point, all primary teeth have been replaced by permanent teeth, and although the permanent teeth have initially established the occlusion, most patients still have growth potential in their jaw bones. [37]

Orthodontic treatment during the early stage of permanent dentition and occlusion establishment has its time advantage. In most cases, after the early orthodontic treatment during this stage, comprehensive orthodontic treatment during the permanent dentition stage can begin seamlessly, which can avoid a long interval between the two treatment phases and the resulting occlusive instability and retention issues. [38] However, it is necessary for the orthodontist to accurately judge the growth and development stage that the patient is in, otherwise, early orthodontic treatment for malocclusion may not be effective and may even fail. Orthodontic treatment during the early stage of permanent dentition and occlusion establishment offers a time advantage. Typically, after completing the early orthodontic treatment, comprehensive orthodontic treatment during the permanent dentition stage can begin seamlessly, avoiding lengthy intervals between treatment phases and issues with occlusal instability and retention difficulty. [38] However, before performing any treatment for malocclusion, orthodontists must accurately assess the patient's stage of growth and development. Otherwise, early orthodontic treatment may prove ineffective or even fail.

7.1. Anterior Crossbite Caused by Maxillary Sagittal Underdevelopment

Maxillary sagittal underdevelopment can lead to anterior

crossbite. Studies have shown that the earlier the traction is applied to the anterior maxilla, the greater the skeletal effect of the traction, while delayed treatment leads to more dental effects. [39] In clinical practice, anterior maxillary traction is commonly used during the early mixed dentition phase. However, some patients may have already missed this optimal treatment window by the time they seek treatment. In such cases, if the orthodontist can guide the anterior maxillary traction using the patient's growth potential in combination with comprehensive orthodontic treatment, it may be possible to avoid the need for orthognathic surgery to some extent. [40]

7.2. Posterior Crossbite Caused by Narrow Maxillary Width

For cases where narrow maxillary width causes unilateral or bilateral posterior crossbite, a maxillary expansion appliance can be utilized to widen the maxillary arch. This treatment is typically performed during the early permanent dentition stage, while the midpalatal suture is still open. After expansion, comprehensive orthodontic treatment can be initiated promptly to adjust the posterior occlusion and ensure stability. However, if expansion is carried out too early during the mixed dentition phase, the midpalatal suture may open to a greater extent, but primary teeth replacement may not be complete, and a lengthy retention period is required before fixed orthodontic treatment could begin. During this period, various factors can affect the patient's posterior occlusal function, which can significantly extend the duration of orthodontic treatment. [41]

7.3. Maxillary Overdevelopment

For patients in the growth and development stage, a headgear facebow can be used in conjunction with fixed orthodontic appliance to inhibit further maxillary growth. Many studies have shown that the application of headgear facebow has a certain inhibitory effect on maxillary growth, but its long-term stability may not be that satisfactory. [42]

7.4. Mandibular Underdevelopment

Many studies have shown that for patients with skeletal Class II malocclusion caused by mandibular underdevelopment, the merits of early treatment with functional appliances are not significantly demonstrated in the later Phase II fixed orthodontic treatment during the permanent dentition stage, and the treatment outcome is not statistically different from that of fixed orthodontic treatment alone. [40]

7.5. Mandibular Overdevelopment

For patients with anterior crossbite and skeletal Class III malocclusion caused by mandibular overdevelopment, observation of the patient's jaw growth is often adopted during the early permanent dentition stage. After the peak of growth and development, the patient's malocclusion can be re-assessed, and a decision can be made whether to use camouflage treatment or orthodontic-orthognathic combined treatment. [43] Chin cup have a certain effect in early

treatment, and many studies have shown that chin cup treatment for mandibular protrusion-induced malocclusion can have satisfactory short-term effects, mainly with lingual inclination of the lower anterior teeth and clockwise rotation of the mandible. However, the treatment outcome lacks long-term stability. For such patients, anterior traction during the early permanent dentition stage should be avoided to prevent the worsening of facial appearance, prolonging of treatment time, and increase of costs. [44]

8. Conclusion

In summary, each type of malocclusion have its own inducing factors and developmental characteristics at different stages. Clinical practitioners should understand the distinctive features of each stage of growth and development, use various diagnostic methods to take advantage of the patient's peak growth potential. They should guide patients to actively treat dental diseases during primary and early permanent dentition stages, identify and treat any primary respiratory system diseases, and diagnose any systemic diseases or syndromes that may cause facial malocclusion. The challenge in early orthodontic treatment under occlusive guidance lies not only in the choice of technical methods but also in the clinician's ability to predict potential oral diseases and malocclusions that may arise during the child's growth and development process. [45] To achieve this, clinicians must adopt a "preventive" mindset, focus on the "management of pediatric occlusive guidance", utilize suitable orthodontic treatment techniques, select the appropriate intervention timing, and seize the golden opportunity of the patients' growth and development to prevent the onset and progression of malocclusion, thus ultimately achieving a stable and visible treatment effect. [46] This will help guarantee a smooth transition from primary to permanent teeth, while also establishing a healthy and stable occlusion for the early permanent dentition.

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