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Recent developments in orthodontic treatment-an overview

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***Abstract*-Background:** Recent developments in orthodontic treatment have significantly impacted the management of various dental and skeletal issues in preadolescent patients. These advancements encompass a wide range of approaches aimed at addressing problems during the mixed-dentition phase, particularly skeletal discrepancies. Growth modification, camouflage, and orthognathic surgery are primary strategies used to correct these discrepancies. **Aim:** The aim of this overview is to present a comprehensive summary of recent developments in orthodontic treatment, focusing on growth modification strategies applied to address skeletal and dental issues

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in preadolescent patients. **Methods:** This overview examines various orthodontic treatment methods, including growth modification techniques such as the use of headgear, functional appliances, and orthognathic surgery. The discussion also explores the application of these methods to different types of malocclusions and skeletal discrepancies, particularly anteroposterior, transverse, and vertical problems. **Results:** Growth modification has shown variable success in managing skeletal discrepancies, with treatment outcomes often depending on patient compliance and the timing of intervention. While some studies support early intervention, others suggest that late mixed-dentition treatment can be equally effective. The effectiveness of treatment varies based on the type of malocclusion and the specific growth modification technique employed. **Conclusion:** Orthodontic treatment in the mixed-dentition phase presents unique challenges and opportunities. Growth modification, although not an exact science, can achieve modest skeletal changes, particularly when applied during periods of active growth. Early intervention may offer psychosocial benefits and reduce the risk of trauma, but individualized treatment planning remains crucial for optimal outcomes.

Keywords-orthodontic treatment, growth modification, skeletal discrepancies, mixed-dentition, malocclusion, early intervention, functional appliances.

Introduction

In addressing treatment for issues during the mixed-dentition phase, it is essential to clearly define both the specific problem and the objectives of the treatment. At this developmental stage, definitive or complete solutions are rarely feasible, although some straightforward and isolated dental issues might be resolved. As outlined in previous sections, information regarding the patient's issues is collected through interviews with the patient and their parents, along with a clinical examination. The clinician then assesses this information to establish a set of treatment goals that address both functional and aesthetic concerns of the patient and clinician. Once these goals are set, a list of orthodontic issues is compiled from the clinical database and prioritized from most to least severe (1). Following the creation and prioritization of the problem list, potential solutions for each issue should be identified. This solution list must be thorough, considering all feasible solutions for each problem independently of other issues. Once this list is compiled, the clinician seeks overlapping solutions applicable to multiple problems. In some instances, the optimal solution for one issue may also address others, simplifying the treatment plan. However, often, a solution for one issue might not be applicable to others and could even exacerbate secondary problems. Therefore, the treatment plan should reflect the established treatment goals. Given that treatment planning is not entirely a scientific process, clinical judgment is required to formulate an effective plan in such scenarios.

Clinicians are trained to recognize functional and aesthetic issues, which means the problem list may not always align with the concerns of the patient and their family. It is crucial to carefully consider these concerns when presenting the problem list and treatment plan, as they may influence the direction and satisfaction with the treatment. Motivation for treatment can often be derived from these concerns. If the patient is internally motivated and eager for treatment, cooperation during the process tends to be high, reducing the need for extensive parental support. Conversely, external motivation, where the parent drives the desire for treatment, necessitates ongoing parental involvement for successful treatment completion. If the primary complaint or reason for seeking treatment is low on the priority list or will be addressed later in the plan, it is important to provide an explanation to the patient and their family to clarify this prioritization.

Skeletal Problems

Orthodontic challenges in preadolescent patients are generally classified as either dental or skeletal in nature, with the complexity of these issues varying significantly. While many dental issues fall within the scope of general dental practitioners, skeletal problems, which are identified through facial profile analysis and confirmed by supplementary diagnostic methods, are best managed by a specialist. However, it is crucial for general practitioners to understand the various approaches to treating skeletal discrepancies. There are three primary approaches to managing skeletal discrepancies: growth modification, camouflage, and orthognathic surgery. Growth modification aims to alter skeletal relationships by utilizing the patient's remaining growth potential to adjust the size or position of the jaws. Camouflage and orthognathic surgery are typically considered for adolescent patients who have little to no remaining growth or for adult patients who are no longer growing. Camouflage orthodontic treatment seeks to mask a mild skeletal discrepancy by moving the teeth within the jaws so that they align properly. Although the skeletal issue persists, it is concealed by a compensated occlusion and acceptable facial aesthetics. Orthognathic surgery involves repositioning the jaws and teeth into a normal or near-normal alignment using surgical procedures along with pre- and post-surgical orthodontic treatment (2). In the case of mixed-dentition patients, only growth modification or no treatment are considered reasonable options for skeletal intervention.

Growth modification during the early mixed-dentition years is based on several assumptions that may not be as straightforward as they seem. First, for growth to be modified, the child must still be growing. Most normal children between the ages of 6 and 12 are actively growing, including their facial structures. Additionally, it has been traditionally believed that skeletal issues are easier to correct if the child is undergoing maximal facial growth during treatment. Although data supporting this belief are not abundant or conclusive (3), clinicians have long attempted to predict maximum somatic growth and maximal facial growth using various indicators. However, there is significant variability in the amount of facial growth occurring at any given time and in the correlation between facial growth, overall body growth, and other chosen indicators (4–6). Due to this variability, clinicians should utilize as many indicators as possible, such as personal growth history, skeletal growth maturation, secondary sexual characteristics, and the onset of menarche, to make an informed decision about

whether the child is growing at an appropriate rate. Typically, girls enter the adolescent growth spurt, marked by noticeable somatic growth, around the age of 10, while boys do so around the age of 12.

The data do not definitively support the notion that treatment must occur at a specific rate of facial growth to be successful, and experience has shown that most skeletal and dental problems can be effectively managed in one phase during the transition from mixed to permanent dentition. For these reasons, a single stage of orthodontic treatment is the most popular and adequately effective approach. This allows practitioners to manage most problems in a more mature patient who is likely to be both cooperative and compliant. The asynchrony between dental development and rapid facial growth can create situations where a patient may be ready for growth modification but not for orthodontic dental treatment, or vice versa. These cases must be handled individually, balancing dental and skeletal interventions. Additionally, some patients may have pressing issues that necessitate earlier treatment, as discussed later.

Another assumption made during growth modification is that the practitioner can accurately diagnose the source of the skeletal discrepancy and design a treatment that applies the appropriate amount and direction of force to correct the issue. Diagnosis is not an exact science and can be challenging even with the use of cephalometric measurements (7), and the discrepancy may be due to multiple small skeletal issues rather than a single easily identifiable problem. It is important to remember that not all class II or class III malocclusions are the same or caused by a single skeletal factor. Force application to dental and skeletal structures is also not precise, and clinical judgment and treatment response may necessitate adjustments in the amount and direction of force applied to modify growth. Orthodontic treatment for skeletal problems is not a simple "see it and fix it" process. Additionally, growth modification is often just one part of a broader treatment plan. Most appliances used for growth modification, such as headgears and functional appliances, are designed to alter skeletal structures rather than precisely move teeth. While these appliances can cause tooth movement, they are not as precise as fixed orthodontic appliances (braces) and are usually used before or in conjunction with fixed appliances. Consequently, most growth modification treatments are followed immediately or at a later stage by traditional fixed orthodontic appliances to finalize tooth positioning.

There are several theories on how growth modification achieves the desired outcomes. The first theory suggests that growth modification appliances alter the absolute size of one or both jaws. For instance, a class II skeletal profile may be treated by enlarging a deficient mandible to fit a normal-sized maxilla or by limiting the size of an oversized maxilla. Some clinical data show significant size changes, but there is considerable variability in patient responses to growth-modifying appliances, with modest changes in various structures being more common. Alternatively, growth modification may accelerate desired growth without altering the ultimate size or shape of the jaw. A deficient mandible may reach its final size sooner without becoming larger than it otherwise would have been. This requires the clinician to make final dentoalveolar adjustments or compensations to achieve ideal occlusion following growth modification. This type of growth modification response also shows significant individual variability. This

interpretation of growth modification is supported by recent randomized clinical trials demonstrating little difference between early and late treatment groups for patients with skeletal class II malocclusion (8).

A third possibility is that growth modification may alter the spatial relationship between the two jaws. The ultimate size of the jaw and its growth rate remain unchanged, but by modifying the orientation of the jaws relative to each other, a more balanced profile can be achieved. For example, a convex profile and increased lower facial height could be made more proportional if the vertical growth of the maxilla is inhibited, allowing the mandible to rotate upward and forward. This would result in a less convex profile and more ideal vertical relationships. Jaw reorientation might also be successful in a concave class III patient with a short face if the mandible could be rotated downward and backward (more vertical) to create a more acceptable profile. However, reorientation does not work well in class II short faces or class III long faces because correcting one problem (e.g., the vertical dimension) may worsen another problem (e.g., the anteroposterior dimension). A recent meta-analysis review concluded that (1) functional appliances can accelerate forward mandibular growth in prepubertal and adolescent stages, (2) functional appliances can restrain maxillary growth, and (3) functional appliances correct class II malocclusion through both dental and skeletal changes (9).

As evident, growth modification is not an exact science. According to the best available data, it seems that if a patient is growing, modest skeletal changes can typically be achieved during the mixed-dentition years, whether attempted early or late in this developmental period. It may be advisable to attempt these changes during the earlier mixed-dentition years if patients have aesthetic concerns or are prone to trauma. Several studies have shown that early orthodontic treatment positively impacts a patient's self-esteem and reduces negative social interactions (10,11). However, questions remain regarding the effect of early treatment on patient quality of life. While orthodontic treatment appears to improve certain aspects of quality of life, particularly aesthetics, it does not necessarily enhance social acceptance. Additionally, treatment does not seem to improve oral health status or oral function compared to untreated populations (12). A Cochrane review on early orthodontic treatment and trauma prevention indicated a reduction in dental trauma, although there was considerable uncertainty regarding this finding (13). Other studies question whether early treatment provides a protective benefit against incisal trauma (14). A cautious approach may involve evaluating each patient individually, considering their psychosocial well-being and trauma risk factors. Otherwise, conventional late mixed-dentition treatment seems equally reasonable.

Growth Modification Applied to Anteroposterior Problems

Anteroposterior skeletal problems are categorized into class II and class III malocclusions. However, these classifications alone are not very informative, as the source of the discrepancy may originate from the maxilla, the mandible, or a combination of both. Therefore, the first step in patient evaluation is to identify the source of the problem and then design a treatment plan tailored to address it. Although this approach suggests that these problems can be clearly identified and

treated with specific strategies, the reality is more complex. In many moderately severe cases of anteroposterior problems, various approaches may be effective, often depending more on patient compliance than on clinical expertise (15).

Class II Growth Modification

A class II malocclusion results from maxillary protrusion, mandibular retrusion, or a combination of both. The management of class II maxillary protrusion has traditionally involved headgear therapy, which aims to restrict or redirect maxillary growth. This approach is supported by retrospective studies and randomized clinical trials . Headgear applies a distal force on the maxillary dentition and the maxilla, with the extent of dental and skeletal movement depending on the amount and duration of force application. However, in practice, it is unlikely that only the teeth or only the bones are moved selectively .

Generally, both skeletal and tooth movements are more significant with higher forces, although tooth movement can occur with either heavy or light forces. One method involves applying forces of 12 to 16 ounces per side for 12 to 14 hours, monitoring the skeletal and dental changes, and adjusting the treatment accordingly. The response varies depending on the type of headgear used and the direction of force exerted. The most common types of headgear, cervical and high-pull, provide predominantly distal and occlusal forces, and distal and apical forces, respectively. Traditionally, a headgear that extrudes posterior teeth is avoided in individuals with a long face or limited overbite, while it may be useful in patients with a short face and deep bite. Class II maxillary protrusion can also be managed using removable functional appliances such as activators, bionators, or twin blocks. Although these functional appliances primarily aim to stimulate mandibular growth, studies suggest they also have secondary effects of restricting forward movement of the maxillary skeletal and dental structures . This occurs because the forward-postured mandible tends to return to a more distal position due to distal muscle and soft tissue forces, which are transmitted through the appliance to the maxilla and maxillary teeth, causing the maxillary teeth to tip lingually and the mandibular teeth to tip facially (16-20).

Another functional appliance used in class II treatment is the Herbst appliance, a fixed device designed to reposition the mandible forward. It is secured with bands, stainless steel crowns, bonding, or a cemented cast framework, and uses a pin and tube apparatus to force the mandible forward. This constant force affects the maxilla and both maxillary and mandibular teeth as the mandible attempts to return to a more distal position. The Herbst appliance has shown similar changes to those of other functional appliances in randomized clinical trials . The use of temporary anchorage devices (TADs) in combination with the Herbst appliance may reduce some of the movement of the lower incisors . When a class II malocclusion results from a mandibular deficiency, treatment focuses on altering the mandibular position. Mandibular-deficient patients are usually treated with removable or fixed functional appliances that position the mandible forward in an attempt to stimulate or accelerate mandibular growth. Retrospective clinical studies have shown that these appliances can produce a small average increase in mandibular projection (2 to 4 mm per year) . This has been confirmed by randomized clinical trials . However, patient responses vary significantly, and in

many cases, the increased growth does not fully correct the class II skeletal problem for several reasons.

First, the amount of growth may not be sufficient to overcome the discrepancy. Second, the growth that does occur would need to be specifically directed to produce an anteroposterior change. However, this is often not the case, as dental eruption and vertical growth also occur. The interaction between anteroposterior and vertical dimensional changes reduces the ultimate mandibular projection and the correction of the class II malocclusion, as the mandible grows downward and forward rather than straight forward. The remaining anteroposterior discrepancy is managed by restricting maxillary growth, tipping the maxillary teeth back, and tipping the mandibular teeth forward. Different appliances can be designed to exaggerate the secondary responses of maxillary restriction and dental movement if needed. The Herbst appliance is also used in mandibular-deficient patients. Some studies indicate that headgear treatment may increase mandibular growth . In general, a review of class II treatments suggests that headgear and functional appliances are equally effective in treating class II malocclusion . Headgear appears to have a small restrictive influence on maxillary position, while functional appliances tend to move the B point forward, leading to an ANB improvement of approximately 1 degree with either approach. A significant portion of the change is dental in nature; headgear influences maxillary molar position distally, whereas functional appliances tend to move the lower molar mesially and procline the lower incisors (21-25).

Class III Growth Modification

Class III malocclusion, like class II, results from an imbalance in the position of the maxilla, the mandible, or both. The first scenario involves a small maxilla, or true midface deficiency, which can be treated using a reverse-pull headgear or facemask that applies anteriorly directed force on the maxilla. The facemask exerts this force through an appliance attached to the teeth, which also causes some tooth movement. Some clinicians combine facemask therapy with maxillary expansion (either rapid or slow) to enhance the transverse coordination of the arches and to facilitate the anterior movement of the maxilla by altering the bony interfaces with other skeletal structures. Studies suggest that maxillary expansion with protraction results in less maxillary incisor movement compared to protraction alone. However, one prospective study found no significant difference between the expansion and non-expansion approaches.

Another approach involves using a facemask in combination with miniplates attached to the maxilla. This method is typically applied during the late mixed dentition, around 10 to 11 years of age, and has shown greater skeletal change, particularly in the zygomatic area. Alternatively, miniplates can be attached to both the maxilla and mandible, allowing for the use of intraoral elastics at approximately the same age. This technique results in substantial skeletal changes without the need for an extraoral appliance, allowing the elastic force to be applied continuously.

The timing of this treatment has been a subject of debate. Some experts advocate for initiating treatment soon after the eruption of the permanent incisors, while

others prefer to wait a bit longer. However, it is generally agreed that post-pubertal treatment is not suitable for growth modification. Data indicate that there is little difference in the anteroposterior treatment effect whether treatment is started early or late, as long as it is completed before the age of 10 to 11. Unfortunately, the long-term success of maxillary protraction remains uncertain. A significant concern is that incorrect diagnosis or treatment in patients whose class III malocclusion is due to mandibular protrusion often leads to treatment failure. Even among correctly diagnosed patients, approximately one in four may require additional treatment to correct the skeletal malocclusion. Functional appliances designed to stimulate maxillary growth generally do not seem effective for class III malocclusion. In patients with minor class III problems, these appliances may result in an improved facial profile due to downward and backward rotation of the mandible. The occlusion improves mainly due to facial tipping of the maxillary incisors and lingual tipping of the lower incisors (26-27).

Historically, class III mandibular protrusion has been managed with chin cup therapy, which applies distal and superior force through the chin to inhibit or redirect growth at the condyle. Although animal studies have shown some change in absolute mandibular size, clinical application in humans has been less successful. The typical short-term response to chin cup therapy involves distal rotation of the mandible and lingual tipping of the lower incisors, making it suitable for patients with mild mandibular protrusion and short to normal vertical proportions. However, chin cup therapy is contraindicated in patients with a long lower face, as the anteroposterior correction may lead to an increased vertical dimension. Long-term studies of chin cup therapy suggest that while transient positive changes can occur, the long-term outcomes are often indistinguishable from those in untreated patients.

In summary, the treatment of class III malocclusion in the mixed dentition hinges on whether the issue is a maxillary deficiency or mandibular excess. For mandibular excess, clinicians can choose between a chin cup or a class III type functional appliance. Both methods have been shown to restrict mandibular growth but have little effect on maxillary position. Treatment is recommended before the age of 10. For maxillary deficiency, a reverse-pull headgear can move the maxilla forward, although it may also cause proclination of the upper incisors and downward and backward rotation of the mandible, increasing lower anterior facial height. If treatment is delayed until the late mixed dentition when permanent teeth have erupted sufficiently for bone miniplates to be placed, a combination of upper and lower miniplates with continuous intermaxillary elastic traction can stimulate upper jaw growth and restrain lower jaw growth without dental compensations. However, the response to class III growth modification is highly variable and difficult to predict on an individual basis (28).

Growth Modification Applied to Transverse Problems

In preadolescents, the most common transverse problem is maxillary constriction with a posterior crossbite. Addressing this issue early, when the child is mature enough to accept treatment, can prevent complications such as crossbites of the permanent teeth, increase arch length, and simplify future diagnostic decisions that could be complicated by functional shifts. Early correction is particularly

important in cases involving a mandibular shift, as untreated shifts can lead to long-term facial asymmetry due to soft tissue enlargement and, in some cases, mandibular asymmetry. Therefore, treatment before adolescence and before midpalatal suture bridging is generally recommended.

Appliances for Correcting Maxillary Constriction (29-38):

1. **Quad Helix and W Arch:**
    - These appliances are used to manage maxillary constriction in young children (ages 3 to 6).
    - They provide both skeletal and dental movement, with more skeletal change occurring at a younger age.
    - As the patient ages, more dental change and less skeletal change are observed due to the increasing interdigitation of the midpalatal suture.
2. **Rapid Palatal Expansion (RPE):**
    - For older preadolescent patients where the midpalatal suture may be closing, an appliance capable of delivering larger forces is required for skeletal correction.
    - RPE involves an appliance cemented or bonded to the teeth, which is expanded at a rate of 0.5 mm/day, delivering 2000 to 3000 grams of force.
    - During the active phase of treatment, skeletal structures expand with minimal dental movement. However, during retention, there is a tendency for the skeletal structures to relapse toward the midline, causing the teeth to move relative to the bones.
    - The active phase typically lasts 10 to 14 days.
3. **Slow Palatal Expansion:**
    - This method uses a similar appliance to RPE but with force levels calibrated to 900 to 1300 grams.
    - Slow palatal expansion, coupled with a slower activation rate, results in both dental and skeletal movement, with proponents arguing that this approach is more physiologic and stable.
    - There is some evidence, based on cone beam computed tomography (CBCT) studies, that both rapid and slow maxillary expansion can lead to loss of buccal bone (height and thickness). However, these findings should be interpreted cautiously due to the resolution of the imaging.

Buccal Shields and Functional Appliances:

- Transverse growth modification can also be achieved using acrylic or wire buccal shields attached to functional appliances or lip bumpers. These devices relieve the teeth and alveolar structures from the resting pressure of the cheek muscles and soft tissues.
- Transverse expansion of 3 to 5 mm can be achieved, although the changes can vary considerably.
- The stability of these changes, and whether they are dental or skeletal in nature, is still uncertain, as there are no controlled experimental studies to provide definitive answers.

Active vs. Passive Expansion:

- Transverse expansion can be accomplished through passive or active movement of teeth.
- **Passive Expansion:** Acrylic or wire buccal shields remove lip and cheek pressure, allowing movement of both maxillary and mandibular teeth.
- **Active Expansion:** This is performed using a W arch–type appliance or a screw-type appliance. The choice of appliance depends on the patient's age (which indirectly reflects the degree of interdigitation of the palatal suture) and the amount of expansion required.
- Studies indicate that there is less risk of buccal alveolar bone change if the movement is completed at a younger age, rather than after the complete eruption of the permanent dentition.

Growth Modification Applied to Vertical Problems

Vertical skeletal problems manifest as either long or short facial heights, typically below the palatal plane. In short-faced individuals, there is a reduced mandibular plane angle and under-erupted teeth, whereas long-faced individuals have an increased mandibular plane angle, lower facial height, and increased dental eruption compared to those with a normal facial profile.

Managing Vertical Skeletal Problems:

- Vertical skeletal problems can be managed with growth modification techniques, although maintaining the correction is challenging due to the long duration of vertical facial growth and the tendency for the original growth pattern to recur.
- Even successful treatment may not entirely prevent the recurrence of the original problem, as the face continues to grow vertically for an extended period (41).

Vertical Excess Management

Vertical skeletal excess can be managed using either extraoral or intraoral forces to control vertical development and eruption of teeth.

1. **Extraoral Force (High-Pull Headgear):**
    - High-pull headgear is applied to the maxillary first molars, delivering force in a superior and distal direction.
    - This approach aims to inhibit vertical development of the maxilla and restrict the eruption of posterior maxillary teeth.
    - However, because no force is applied to the mandibular teeth, they are free to erupt, potentially leading to compensatory eruption that may negate the benefits of the headgear. This can result in downward and backward rotation of the mandible instead of the desired forward projection.
2. **Intraoral Force (Functional Appliances):**
    - Functional appliances can be designed to block the eruption of both maxillary and mandibular teeth. These appliances force the mandible into an increased vertical rest position.
    - The mandible's natural tendency to return to its original rest position creates a force transmitted to the maxilla and teeth in both arches, directing mandibular growth forward.

- This approach aims to reduce vertical growth and promote forward mandibular projection, minimizing the increase in lower and total face height.
- **Temporary Anchorage Devices (TADs):**
  - TADs are small titanium screws placed into cortical bone to provide a stable anchor for applying force to teeth without moving other teeth.
  - In cases of vertical excess, TADs can be used to apply intrusive force to the maxillary posterior teeth, helping to control vertical facial development.
  - However, placing TADs in younger patients with mixed dentition can be challenging due to the presence of unerupted teeth and less stable cortical bone. In such cases, TADs may be placed in the palate, where they are better retained.
- The success of these treatments relies heavily on excellent patient cooperation, and treatment must be maintained or retained throughout the patient's growth period to prevent relapse.

Vertical Deficiency Management

Vertical skeletal deficiencies can be addressed using headgear or functional appliances, depending on the anteroposterior relationship of the teeth.

1. **Headgear:**
   - Cervical pull headgear is used when there is a need to direct the maxilla distally and extrude the maxillary posterior teeth.
   - The force vector applied by this headgear helps manage vertical deficiencies by encouraging vertical growth and increasing facial height.
2. **Functional Appliances:**
   - These appliances are generally designed to inhibit the eruption of upper and lower anterior teeth while promoting the eruption of posterior teeth.
   - By doing so, functional appliances can help increase vertical facial height.
   - Additionally, in Class II cases, lower molar eruption is encouraged to bring the molars forward into a Class I relationship, while in Class III cases, upper molar eruption is encouraged.

General Considerations:

- Similar to the management of vertical skeletal excess, treatments for vertical deficiencies must account for the patient’s growth pattern, which often tends to recur until growth is complete.
- Retention strategies should be carefully designed to prevent relapse once treatment is finished.

Conclusion

Orthodontic treatment during the mixed-dentition phase is a dynamic and multifaceted process that involves careful assessment, diagnosis, and strategic intervention. The recent developments in orthodontic treatment highlight the

importance of early identification and management of skeletal and dental discrepancies. Growth modification, one of the central strategies, aims to harness the patient's remaining growth potential to address skeletal issues. This approach, while effective in many cases, is not without its limitations. The success of growth modification often depends on various factors, including the accurate diagnosis of the skeletal problem, the timing of intervention, and the patient's compliance. The treatment of anteroposterior, transverse, and vertical problems requires a tailored approach that considers the individual patient's needs and growth patterns. For instance, while growth modification can be effective for class II and class III malocclusions, the outcomes are highly variable, and the long-term success of such treatments is not guaranteed. Similarly, transverse problems such as maxillary constriction necessitate early intervention to prevent complications and facilitate future orthodontic procedures. One of the critical insights from recent research is the recognition that orthodontic treatment is not a one-size-fits-all solution. The variability in patient responses to treatment underscores the need for personalized treatment plans that balance skeletal and dental interventions. Moreover, while early intervention can offer psychosocial benefits and reduce trauma risks, it is essential to weigh these benefits against the potential for equally effective outcomes with later treatment. In conclusion, recent developments in orthodontic treatment emphasize the importance of a comprehensive and individualized approach to managing skeletal and dental issues in preadolescent patients. Growth modification remains a valuable tool, but its application must be carefully considered within the broader context of the patient's overall treatment plan. By focusing on the patient's unique needs and growth potential, orthodontic professionals can achieve optimal functional and aesthetic outcomes, thereby enhancing the overall quality of life for their patients.

References

1. Proffit, W. R., Fields, H. W., & Sarver, D. M. (2012). Contemporary orthodontics (5th ed.). Mosby-Year Book.
2. Proffit, W. R., White, R. P., & Sarver, D. M. (2003). Contemporary treatment of dentofacial deformity. Mosby-Year Book.
3. Hagg, U., Pancherz, H., & Taranger, J. (1987). Pubertal growth and orthodontic treatment. In D. S. Carlson & K. A. Ribbens (Eds.), Craniofacial growth during adolescence (Monograph 20, Craniofacial Growth Series). Center for Human Growth and Development, University of Michigan.
4. Baccetti, T., Franchi, L., & McNamara, J. A., Jr. (2002). An improved version of the cervical vertebral maturation (CVM) method for the assessment of mandibular growth. Angle Orthodontist, 72(4), 316–323.
5. Chertkow, S. (1980). Tooth mineralization as an indicator of the pubertal growth. American Journal of Orthodontics and Dentofacial Orthopedics, 77, 79–91.
6. Thompson, G. W., Popovich, F., & Anderson, D. L. (1976). Maximum growth changes in mandibular length, stature, and weight. Human Biology, 48, 285–293.
7. Anderson, G., Fields, H. W., Beck, F. M., et al. (2006). Development of cephalometric norms using a unified facial and dental approach. Angle Orthodontist, 76, 557–563.

8. Tulloch, J. F. C., Phillips, C., & Proffit, W. R. (1998). Benefit of early class II treatment: Progress report of a two-phase randomized clinical trial. American Journal of Orthodontics and Dentofacial Orthopedics, 113, 62–72.
9. De Clerk, H., & Proffit, W. (2015). Growth modification of the face: A current perspective with emphasis on class III treatment. American Journal of Orthodontics and Dentofacial Orthopedics, 148, 37–46.
10. O'Brien, K., Wright, J., Conboy, F., et al. (2003). Effectiveness of early orthodontic treatment with the twin-block appliance: A multicenter, randomized, controlled trial. Part 2: Psychosocial effects. American Journal of Orthodontics and Dentofacial Orthopedics, 124(5), 488–494.
11. Liu, Z., McGrath, C., & Hägg, U. (2009). The impact of malocclusion/orthodontic treatment need on the quality of life: A systematic review. Angle Orthodontist, 79(3), 585–591.
12. Kiyak, H. A. (2008). Does orthodontic treatment affect patients' quality of life? Journal of Dental Education, 72(8), 886–894.
13. Thiruvenkatachari, B., Harrison, J., Worthington, H., et al. (2015). Early orthodontic treatment for class II malocclusion reduces the chance of incisal trauma: Results of a Cochrane systematic review. American Journal of Orthodontics and Dentofacial Orthopedics, 148, 47–59.
14. Koroluk, L. D., Tulloch, J. F., & Phillips, C. (2003). Incisor trauma and early treatment for class II division 1 malocclusion. American Journal of Orthodontics and Dentofacial Orthopedics, 123, 117–126.
15. Baumrind, S., Korn, E. L., Isaacson, R. J., et al. (1983). Quantitative analysis of the orthodontics and orthopedic effects of maxillary traction. American Journal of Orthodontics and Dentofacial Orthopedics, 84, 384–398.
16. Bookstein, F. L. (1982). On the cephalometrics of skeletal change. American Journal of Orthodontics and Dentofacial Orthopedics, 82, 177–198.
17. O'Brien, K., Wright, J., Conboy, F., et al. (2003). Effectiveness of treatment for class II malocclusion with the Herbst or twin-block appliances: A randomized, controlled trial. American Journal of Orthodontics and Dentofacial Orthopedics, 124, 128–137.
18. Luzi, C., Luzi, V., & Melsen, B. (2013). Mini-implants and the efficiency of Herbst treatment: A preliminary study. Progress in Orthodontics, 14(1), 21.
19. McNamara, J. A., Bookstein, F. L., & Shaughnessy, T. G. (1985). Skeletal and dental changes following functional regulator therapy on class II patients. American Journal of Orthodontics and Dentofacial Orthopedics, 88, 91–110.
20. Remmer, H. R., Manandras, A. N., Hunter, W. S., et al. (1985). Cephalometric changes associated with treatment using the activator, the Frankel appliance, and the fixed appliance. American Journal of Orthodontics and Dentofacial Orthopedics, 88, 363–372.
21. Keeling, S. D., Wheeler, T. T., King, G. J., et al. (1998). Anteroposterior skeletal and dental changes after early class II treatment with bionators and headgear. American Journal of Orthodontics and Dentofacial Orthopedics, 113, 40–50.
22. Baumrind, S., & Korn, E. L. (1981). Patterns of change in mandibular and facial shape associated with the use of forces to retract the maxilla. American Journal of Orthodontics and Dentofacial Orthopedics, 80, 31–47.
23. Southard, T., Marshall, S., Allareddy, V., et al. (2013). An evidence-based comparison of headgear and functional appliance therapy for the correction of class II malocclusions. Seminars in Orthodontics, 19, 174–195.

24. Turley, P. K. (1988). Orthopedic correction of class III malocclusion with palatal expansion and custom protraction headgear. Journal of Clinical Orthodontics, 22, 314–325.
25. Kim, J. H., Viana, M. A., Graber, T. M., et al. (1999). The effectiveness of protraction facemask therapy: A meta-analysis. American Journal of Orthodontics and Dentofacial Orthopedics, 115, 675–685.
26. Vaughn, G. A., Mason, B., Moon, H. B., et al. (2005). The effects of maxillary protraction therapy with or without rapid palatal expansion: A prospective, randomized clinical trial. American Journal of Orthodontics and Dentofacial Orthopedics, 128, 299–309.
27. Sar, C., Arman-Özçırpıcı, A., Uçkan, S., et al. (2011). Comparative evaluation of maxillary protraction with or without skeletal anchorage. American Journal of Orthodontics and Dentofacial Orthopedics, 139, 636–649.
28. Nguyen, T., Cevidanes, L., Cornelis, M. A., et al. (2011). Three-dimensional assessment of maxillary changes associated with bone anchored maxillary protraction. American Journal of Orthodontics and Dentofacial Orthopedics, 139, 790–798.
29. Cha, K. S. (2003). Skeletal changes of maxillary protraction in patients exhibiting skeletal class III malocclusion: A comparison of three skeletal maturation groups. Angle Orthodontist, 73, 26–35.
30. Baik, H. S. (1995). Clinical results of the maxillary protraction in Korean children. American Journal of Orthodontics and Dentofacial Orthopedics, 108, 583–592.
31. Merwin, D., Ngan, P., Hagg, U., et al. (1997). Timing for effective application of anteriorly directed orthopedic force to the maxilla. American Journal of Orthodontics and Dentofacial Orthopedics, 112, 292–299.
32. Wells, A. P., Sarver, D. M., & Proffit, W. R. (2006). Long-term efficacy of reverse pull headgear therapy. Angle Orthodontist, 76, 915–922.
33. Sakamoto, T., Iwase, I., Uka, A., et al. (1984). A roentgenocephalometric study of skeletal changes during and after chin cap treatment. American Journal of Orthodontics and Dentofacial Orthopedics, 85, 341–350.
34. Sugawara, J., Asano, T., Endo, N., et al. (1990). Long-term effects of chincup therapy on skeletal profile in mandibular prognathism. American Journal of Orthodontics and Dentofacial Orthopedics, 98, 127–133.
35. Jamilian, A., Cannavale, R., Piancino, M., et al. (2016). Methodological quality and outcome of systematic reviews reporting on orthopaedic treatment for class III malocclusion: Overview of systematic reviews. Journal of Orthodontics, 43, 102–120.
36. Kilic, N., Kiki, A., & Oktay, H. (2008). Condylar asymmetry in unilateral posterior crossbite patients. American Journal of Orthodontics and Dentofacial Orthopedics, 133, 382–387.
37. Bell, R., & LeCompte, E. (1981). The effects of maxillary expansion using a quad helix appliance during the deciduous and mixed detentions. American Journal of Orthodontics and Dentofacial Orthopedics, 79, 152–161.
38. Haas, A. J. (1965). The treatment of maxillary deficiency by opening the midpalatal suture. Angle Orthodontist, 35, 200–217.
39. Hicks, E. (1978). Slow maxillary expansion: A clinical study of the skeletal versus the dental response to low magnitude force. American Journal of Orthodontics and Dentofacial Orthopedics, 73, 121–141.

40. Brunetto, M., Andriani, J. da S., Ribeiro, G. L., et al. (2013). Three-dimensional assessment of buccal alveolar bone after rapid and slow maxillary expansion: A clinical trial study. American Journal of Orthodontics and Dentofacial Orthopedics, 143(5), 633–644.
41. Fields, H. W., Proffit, W. R., Nixon, W. L., et al. (1984). Facial pattern differences in long-faced children and adults. American Journal of Orthodontics and Dentofacial Orthopedics, 85, 217–223.

أحدث التطورات في علاج تقويم الأسنان ـ نظرة عامة

الملخص:
الخلفية: أحدثت التطورات الحديثة في علاج تقويم الأسنان تأثيرًا كبيرًا على إدارة مختلف المشكلات السنية والهيكلية لدى المرضى في مرحلة ما قبل البلوغ. تشمل هذه التطورات مجموعة واسعة من الأساليب التي تهدف إلى معالجة المشكلات خلال مرحلة الأسنان المختلطة، وخاصة الفوارق الهيكلية. تُعد تعديل النمو، والتمويه، والجراحة التقويمية الاستراتيجيات الأساسية المستخدمة لتصحيح هذه الفوارق.
الهدف: يهدف هذا الملخص إلى تقديم نظرة شاملة حول أحدث التطورات في علاج تقويم الأسنان، مع التركيز على استراتيجيات تعديل النمو المطبقة لمعالجة المشكلات الهيكلية والسنية لدى المرضى في مرحلة ما قبل البلوغ.
الأساليب: يستعرض هذا الملخص مختلف طرق علاج تقويم الأسنان، بما في ذلك تقنيات تعديل النمو مثل استخدام جهاز الرأس والأجهزة الوظيفية والجراحة التقويمية. كما يستكشف النقاش تطبيق هذه الأساليب على أنواع مختلفة من سوء الإطباق والفوارق الهيكلية، وخاصة المشكلات الأمامية-الخلفية، العرضية، والطولية .
النتائج: أظهرت تعديل النمو نجاحًا متباينًا في إدارة الفوارق الهيكلية، حيث تعتمد نتائج العلاج غالبًا على امتثال المريض وتوقيت التدخل. بينما تدعم بعض الدراسات التدخل المبكر، تشير أخرى إلى أن علاج الأسنان المختلطة المتأخر يمكن أن يكون بنفس الفعالية. تتفاوت فعالية العلاج بناءً على نوع سوء الإطباق والتقنية المحددة لتعديل النمو المستخدمة.
الخلاصة: يمثل علاج تقويم الأسنان في مرحلة الأسنان المختلطة تحديات وفرصًا فريدة. يمكن أن يحقق تعديل النمو تغييرات هيكلية متواضعة، خاصةً عند تطبيقه خلال فترات النمو النشط. قد يوفر التدخل المبكر فوائد نفسية اجتماعية ويقلل من خطر الإصابة، لكن يظل التخطيط العلاجي الفردي ضروريًا لتحقيق أفضل النتائج.
الكلمات المفتاحية: علاج تقويم الأسنان، تعديل النمو، الفوارق الهيكلية، الأسنان المختلطة، سوء الإطباق، التدخل المبكر، الأجهزة الوظيفية