Malocclusion: A Comprehensive Overview

Mohammed Daifallah Almutairi[1], Nadiah Abdulwasea Asrar[2], Wejdan Ahmed Aljamaan[3], Alharith Hani Sagga[4], Saleh Abdulaziz Aldubayyan[5], Fatimah suliman Alshehri[6], Salha Mohammed Madkhali[7], Abdullah alhammad[8], Fahad Abdulaziz Ali Alhajri[9], Majdah Salem Al hejali[10], Ghada Alshahrani[11]

[1]Dental Assistant,West Riyadh Dental Clinics Complex,Saudi Arabia, Email: Mohmmedda@moh.gov.sa
[2]General Dentist,West Riyadh dental complex,Saudi Arabia, Email: Nana.a2009@hotmail.com
[3]Dental Assistant,West Riyadh Dental Complex,Saudi Arabia, Email: Waaljamaan@moh.gov.sa
[4]General Dentist,West Riyadh Dental Complex,Saudi Arabia, Email: H-h-s2005@hotmail.com
[5]Dental assistant,Dental Clinics Complex West of Riyadh,Saudi Arabia, Email: Saldubyyan@moh.gov.sa
[6]Dental Assistant,West Riyadh Dental Complex,Saudi Arabia, Email: ffssalshehry@gmail.com
[7]General dentist,Riyadh west dental complex,Saudi Arabia, Email: Salhamadkhali24@gmail.com
[8]General Dentist,MOH,Saudi Arabia, Email: Asalhammad@moh.gov.sa
[9]Dental technician,Dental clinic in West of Riyadh,Saudi Arabia, Email: faaalhajri@moh.gov.sa
[10]Dental assistant,Dental Complex in Almansorah,Saudi Arabia, Email: sho0od2010@gmail.com
[11]Dental assistant, Dental clinic complex west of Riyadh, Saudi Arabia, Email: Ghabalshahrani@moh.gov.sa

ABSTRACT
Malocclusion, the misalignment of teeth or incorrect relationship between the upper and lower dental arches, is a prevalent condition with far-reaching consequences beyond aesthetics. This comprehensive paper explores the multifaceted nature of malocclusions, delving into their etiology, classification, diagnosis, treatment modalities, potential complications, and future directions. The etiology of malocclusions involves a complex interplay of genetic and environmental factors, influencing the development and positioning of dental and craniofacial structures. Diagnosis relies on a thorough clinical examination, radiographic imaging, and the utilization of advanced techniques like cone-beam computed tomography (CBCT). Treatment modalities encompass a range of orthodontic appliances, dental procedures, and, in severe cases, orthognathic surgery. Potential complications of untreated malocclusions include periodontal problems, functional issues, dental problems, and psychosocial impacts. Ongoing research and technological advancements are shaping the future of malocclusion management, with emerging trends such as digital orthodontics, clear aligner therapy, accelerated tooth movement techniques, and personalized treatment approaches. By understanding the complexities of malocclusions and embracing interdisciplinary collaboration, orthodontists and dental professionals can provide comprehensive and effective care, improving patient outcomes and enhancing overall well-being.

INTRODUCTION

Malocclusion, a term derived from the Latin words "mal" (bad) and "occlusio" (closure), refers to the misalignment of teeth or incorrect relationship between the upper and lower dental arches. This condition not only affects dental aesthetics but can also lead to functional problems, periodontal complications, and psychological distress (Ghodasra& Brizuela, 2023). The impact of malocclusions extends beyond the oral cavity, influencing an individual's overall health and well-being. This paper aims to provide an in-depth exploration of malocclusion, delving into its etiology, classification, diagnosis, treatment modalities, potential complications, and emerging trends in the field.

Definition and Classification

Malocclusions encompass a wide spectrum of dental irregularities, including crowding, spacing, deep overbites, excessive overjets, underbites, crossbites, and open bites. The classification of malocclusions is primarily based on the relationship between the maxillary and mandibular dental arches, as well as the position of the teeth within each arch (Masucci et al., 2020).

The most widely accepted classification system, introduced by Edward H. Angle in the late 19th century, categorizes malocclusions into three main classes:

1. Class I: This class involves a normal mesiodistal relationship between the maxillary and mandibular dental arches, but with malpositioned teeth within each arch, such as crowding, spacing, or rotations.

2. Class II: Class II malocclusions are characterized by a distal relationship of the mandibular dental arch relative to the maxillary arch. This results in an increased overjet (protruding maxillary incisors), often accompanied by a convex facial profile. Class II malocclusions are further divided into Division 1 (with proclined maxillary incisors) and Division 2 (with retroclined maxillary incisors).
3. Class III: In Class III malocclusions, the mandibular dental arch exhibits a mesial relationship relative to the maxillary arch, leading to an underbite or reverse overjet. This is often associated with a concave facial profile and mandibular prognathism (Ellis & McNamara, 1984; Uzuner et al., 2019).

Etiology

The etiology of malocclusion is multifactorial, involving a complex interplay of genetic and environmental factors. Genetic factors play a pivotal role in determining the size, shape, and position of the jaws and teeth, as well as the growth and development patterns of the craniofacial structures (Xue et al., 2010; Cakan et al., 2012). Specific genetic variations or syndromes can predispose individuals to certain types of malocclusions.

Environmental factors also contribute significantly to the development of malocclusions. Habits such as thumb-sucking, tongue thrusting, and prolonged use of pacifiers or bottles can exert abnormal forces on the developing dentition, leading to malocclusions (Curzon, 1974; Staufert Gutierrez &Carugno, 2023). Additionally, premature loss of primary or permanent teeth, trauma, airway obstructions, allergies, and mouth breathing can disrupt the normal development and eruption of teeth, further contributing to the onset of malocclusions (Elsherif et al., 2022; Jain et al., 2019; Rapeepattana et al., 2019).

Prevalence and Risk Factors

Malocclusions are highly prevalent worldwide, affecting a significant portion of the population across all ages and ethnicities. According to the National Health and Nutrition Examination Survey (NHANES III) conducted in the United States, approximately 60% of individuals aged 12 to 17 years and 65% of adults aged 18 to 50 years exhibited some form of malocclusion (Proffit et al., 1998). However, the prevalence and specific types of malocclusions may vary across different populations and geographical regions due to genetic and environmental factors.

Several risk factors have been identified that increase the likelihood of developing malocclusions:
1. Genetic predisposition: Certain genetic variations or inherited craniofacial patterns can predispose individuals to malocclusions.
2. Craniofacial anomalies: Congenital defects or syndromes affecting the development of the craniofacial structures can lead to malocclusions.
3. Early childhood habits: Prolonged thumb-sucking, pacifier use, or tongue-thrusting habits can interfere with normal dental and jaw development.
4. Premature loss of primary teeth: Early loss of primary teeth can disrupt the normal eruption sequence and positioning of permanent teeth.
5. Trauma: Injuries to the developing dentofacial structures, such as fractures or damage to the jaws or teeth, can result in malocclusions.
6. Airway obstructions and mouth breathing: Obstructed nasal airways or chronic mouth breathing can affect the development of the jaws and dental arches.
7. Gender: Some studies have suggested that certain types of malocclusions may be more prevalent in one gender over the other, potentially due to differences in growth patterns and hormonal influences (Lagorsse&Gebeile-Chauty, 2018; Devi et al., 2022).

Diagnosis and Imaging

The diagnosis of malocclusions involves a comprehensive clinical examination and the utilization of various diagnostic tools and techniques to evaluate the severity and complexity of the condition.

Clinical examination:
*   Assessment of the patient's dental arches, occlusion, facial symmetry, and soft tissue patterns.
*   Evaluation of the relationship between the maxillary and mandibular dental arches, as well as the position and alignment of individual teeth.
*   Examination of functional aspects, such as jaw movements, speech, and mastication.

Radiographic imaging:
*   Panoramic radiographs provide a comprehensive view of the jaws and dentition, allowing for the evaluation of tooth positioning and eruption patterns.
*   Cephalometric radiographs (lateral and frontal) are used to assess the craniofacial relationships, skeletal discrepancies, and growth patterns (Foucart et al., 2012; Tanna et al., 2021).

Cone-beam computed tomography (CBCT):
*   CBCT imaging offers three-dimensional (3D) visualization of the craniofacial structures, providing detailed information about bone morphology, tooth positioning, and potential pathologies.

- CBCT scans are particularly valuable in diagnosing and treatment planning for complex malocclusions or skeletal discrepancies (Machado, 2015).

Study models and photographs:
- Dental impressions are taken to create study models, which allow for a detailed analysis of the dental arches and occlusion.
- Intraoral and extraoral photographs document the patient's facial and dental characteristics, aiding in treatment planning and progress monitoring.

Additional diagnostic tools, such as electromyography (EMG) or joint vibration analysis (JVA), may be employed in specific cases to evaluate the function of the masticatory muscles and temporomandibular joints.

Treatment Modalities

The treatment of malocclusions typically involves a multidisciplinary approach, combining various orthodontic appliances, dental procedures, and, in some cases, orthognathic surgery. The specific treatment plan is tailored to the individual patient's needs and the severity of the malocclusion.

Orthodontic appliances:
1. Fixed appliances (braces):
- Traditional metal braces consist of brackets bonded to the teeth and connected by an archwire, exerting controlled forces to move teeth into their desired positions.
- Self-ligating brackets eliminate the need for elastic ligatures, potentially reducing friction and treatment time.
- Lingual braces are positioned on the tongue side of the teeth, offering an aesthetic advantage (Huh et al., 2021).
2. Removable appliances (clear aligners):
- Clear aligners, such as Invisalign, consist of a series of transparent, removable trays that gradually reposition the teeth.
- They offer improved aesthetics and potentially better oral hygiene maintenance compared to fixed appliances (Ke et al., 2019).
3. Functional appliances:
- Twin blocks, Herbst appliances, and other functional appliances are used to correct skeletal discrepancies by modifying jaw positioning and growth patterns.
4. Extraoral appliances:
- Headgear and face masks are extraoral appliances that apply forces to the dentition and jaws to correct specific malocclusions, such as Class II or Class III relationships.

Dental procedures:
- Extractions: In some cases, the removal of specific teeth may be necessary to alleviate crowding or facilitate orthodontic tooth movement.
- Interproximal reduction (IPR): Selective enamel reduction between teeth can create space for tooth alignment.
- Restorative treatment: Dental restorations, such as fillings or crowns, may be required to restore proper tooth anatomy or enhance orthodontic treatment outcomes.

Orthognathic surgery:
- For severe skeletal discrepancies or jaw deformities, orthognathic surgery (jaw surgery) may be required to reposition the jaws and correct the underlying skeletal problems.
- This is often performed in combination with orthodontic treatment, following the "surgery-first" approach or the traditional "orthodontics-first" approach (Choi et al., 2019).

Adjunctive therapies:
- Rapid palatal expansion (RPE): Expands the maxillary arch to correct constricted arches or crossbites (Cannavale et al., 2018).
- Distraction osteogenesis: Gradually separates bony segments to correct skeletal deficiencies or discrepancies.
- Low-level laser therapy or photobiomodulation: May accelerate tooth movement and reduce treatment duration (Karabel et al., 2021).

The duration and complexity of treatment can vary significantly depending on the severity of the malocclusion, patient compliance, and the specific treatment modalities employed.

Potential Complications and Impact

Untreated malocclusions can lead to various complications and adverse effects, impacting not only oral health but also overall well-being and quality of life.

Periodontal problems:
- Malocclusions can contribute to the development of periodontal diseases by creating areas of plaque accumulation, traumatic occlusion, and impaired oral hygiene (Bollen, 2008).
- Improper tooth positioning can lead to gingival inflammation, recession, and bone loss.

Functional issues:
- Severe malocclusions can affect speech clarity, masticatory efficiency (chewing ability), and swallowing patterns, potentially leading to nutritional deficiencies or digestive problems.
- Abnormal occlusal forces can cause temporomandibular disorders (TMD), characterized by pain and dysfunction in the temporomandibular joint and associated muscles (Bowbeer, 2006).

Dental problems:
- Crowding, spacing, and improper tooth positioning can increase the risk of dental caries, erosion, and tooth wear, as well as compromising the longevity of dental restorations.
- Impacted teeth, especially third molars, can lead to complications such as pain, infection, and damage to adjacent teeth (Jain et al., 2019).

Psychosocial impact:
- Malocclusions, especially those affecting facial aesthetics, can have a significant psychological and social impact on individuals.
- Patients may experience low self-esteem, social anxiety, and reduced quality of life, particularly during adolescence and young adulthood (Thomas, 2015).

Orthodontic Treatment Considerations

Orthodontic treatment plays a pivotal role in the management of malocclusions, aiming to restore proper occlusion, improve facial aesthetics, and prevent potential complications. Several factors must be considered when planning and executing orthodontic treatment.

Treatment planning:
- A comprehensive treatment plan should be developed based on the patient's specific needs, taking into account the type and severity of the malocclusion, skeletal discrepancies, growth potential, and overall oral health status (Manosudprasit et al., 2017).
- Careful evaluation of diagnostic records, such as radiographs, study models, and photographs, is essential for accurate treatment planning.

Appliance selection:
- The choice of orthodontic appliances (e.g., fixed appliances, clear aligners, functional appliances) depends on the treatment objectives, patient preferences, and clinical considerations (Ke et al., 2019; Huh et al., 2021).
- Factors such as age, compliance, oral hygiene, and aesthetics play a role in appliance selection.

Anchorage control:
- Proper anchorage control is essential to ensure accurate tooth movement and prevent undesirable side effects.
- Various techniques, such as temporary anchorage devices (TADs) or skeletal anchorage systems, may be employed to enhance anchorage and control tooth movement (Recen et al., 2021).

Biomechanics:
- Understanding the principles of biomechanics and applying appropriate forces is crucial for efficient and controlled tooth movement, minimizing potential side effects and discomfort (Vlachos, 1995).
- Techniques like segmental mechanics, differential force application, and customized archwires may be utilized to optimize treatment outcomes.

Adjunctive therapies:
- In certain cases, adjunctive therapies like low-level laser therapy, photobiomodulation, or corticotomy procedures may be considered to facilitate or accelerate orthodontic tooth movement and potentially reduce treatment duration (Karabel et al., 2021).

Patient compliance:
- Successful orthodontic treatment relies heavily on patient compliance with instructions, proper oral hygiene, and regular follow-up appointments (Kozanecka et al., 2016).
- Poor compliance can lead to prolonged treatment times, compromised results, and potential complications.

Interdisciplinary collaboration:
- Complex cases may require collaboration with other dental specialties, such as periodontics, restorative dentistry, or oral and maxillofacial surgery, to achieve optimal treatment outcomes (Rosa et al., 2020).
- Interdisciplinary communication and coordination are essential for comprehensive patient care.

Maintenance and Retention
Following the active phase of orthodontic treatment, proper maintenance and retention protocols are essential to prevent relapse and ensure long-term stability of the corrected occlusion.

Retention appliances:
- Removable or fixed retainers are typically prescribed to hold the teeth in their corrected positions during the post-treatment retention phase.
- Retainers may be required for an extended period, sometimes even indefinitely, to maintain treatment results.

Periodic monitoring:
- Regular follow-up appointments with the orthodontist are necessary to monitor the stability of the occlusion and make any necessary adjustments to the retention appliances.
- Longer-term monitoring may be recommended, especially in cases involving orthognathic surgery or other complex treatments.

Oral hygiene and periodontal health:
- Maintaining excellent oral hygiene and addressing any periodontal issues are crucial for preserving the health of the supporting structures and preventing potential relapse (Chu et al., 2019).
- Patients should be educated on proper brushing, flossing, and the use of supplemental oral hygiene aids.

Occlusal adjustments:
- Minor occlusal adjustments or selective enamel reshaping may be performed to refine the occlusion and ensure optimal functional and aesthetic outcomes.

Future Directions and Emerging Trends
The field of orthodontics is continuously evolving, with ongoing research and technological advancements shaping the future of malocclusion management.

Digital orthodontics:
- The integration of digital technologies, such as 3D imaging, computer-aided design and manufacturing (CAD/CAM), and virtual treatment planning, is revolutionizing orthodontic diagnosis and treatment (Manosudprasit et al., 2017).
- Digital workflows can streamline processes, improve accuracy, and enhance treatment efficiency.

Clear aligner therapy:
- The use of clear aligners, like Invisalign, has gained significant popularity due to their aesthetic appeal and potential for improved patient comfort and compliance (Ke et al., 2019).
- Advancements in aligner materials, manufacturing techniques, and treatment planning software are expanding the scope of clear aligner therapy.

Accelerated orthodontics:
- Various techniques, including micro-osteoperforation, photobiomodulation, and vibrational devices, are being explored to accelerate orthodontic tooth movement and reduce overall treatment time (Karabel et al., 2021).
- These techniques aim to modulate the biological processes involved in tooth movement, potentially improving treatment efficiency.

Personalized orthodontics:
- Advancements in genetics and epigenetics research may lead to personalized orthodontic treatment plans tailored to individual genetic profiles and predispositions (Xue et al., 2010; Cakan et al., 2012).
- Genetic testing and analysis could help identify patients at higher risk for specific malocclusions or predict treatment outcomes.

Interdisciplinary collaboration:
- The integration of orthodontics with other dental and medical specialties, such as oral and maxillofacial surgery, periodontics, and sleep medicine, will become increasingly important for comprehensive patient care (Ruhl et al., 1994).
- Collaborative approaches can address complex cases and improve overall treatment outcomes.

Robotic-assisted orthodontics:
- The development of robotic systems for precise bracket positioning, archwire manipulation, and treatment adjustments may enhance treatment accuracy and efficiency.
- Robotic technology could potentially reduce treatment times and improve patient comfort.

Regenerative approaches:
- Advancements in tissue engineering and regenerative medicine may lead to novel strategies for addressing skeletal discrepancies or facilitating tooth movement through targeted cellular or molecular interventions.

As the field continues to evolve, embracing technological advancements, personalized treatment strategies, and interdisciplinary collaboration will be essential to provide comprehensive and effective care for individuals affected by malocclusions.

CONCLUSION

Malocclusion is a multifaceted condition that can have significant impacts on oral health, function, and overall well-being. Understanding its etiology, classification, and diagnosis is crucial for developing effective treatment strategies. Orthodontic treatment, in combination with adjunctive therapies and interdisciplinary collaboration, plays a pivotal role in correcting malocclusions and restoring optimal occlusion.

However, the management of malocclusions is not limited to technical aspects alone. It requires a holistic approach that considers the patient's psychological and social well-being, as well as the potential long-term consequences of untreated malocclusions. Ongoing research, evidence-based practices, and technological advancements will continue to refine our understanding and management of this complex condition, ultimately improving patient outcomes and quality of life.

As the field of orthodontics continues to evolve, embracing personalized treatment strategies, interdisciplinary collaboration, and emerging technologies will be essential to provide comprehensive and effective care for individuals affected by malocclusions. By addressing the multifaceted nature of malocclusions, orthodontists and dental professionals can play a vital role in enhancing the oral health, function, and overall well-being of their patients.

REFERENCES

1. Bollen, A. M. (2008). Effects of malocclusions and orthodontics on periodontal health: evidence from a systematic review. Journal of Dental Education, 72(8), 912-918.
2. Bowbeer, G. R. (2006). The four dimensions of orthodontic diagnosis--Part II. Functional Orthodontics, 23(2), 4-6, 8-10, 12-21.
3. Cakan, D. G., Ulkur, F., & Taner, T. U. (2012). The genetic basis of facial skeletal characteristics and its relation with orthodontics. European Journal of Dentistry, 6(3), 340-345.
4. Cannavale, R., Chiodini, P., Perillo, L., &Piancino, M. G. (2018). Rapid palatal expansion (RPE): Meta-analysis of long-term effects. Orthodontics & Craniofacial Research, 21(4), 225-235.
5. Choi, D. S., Garagiola, U., & Kim, S. G. (2019). Current status of the surgery-first approach (part I): concepts and orthodontic protocols. Maxillofacial Plastic and Reconstructive Surgery, 41(1), 10.
6. Chu, I., Kennedy, D., &Hatzimanolakis, P. (2019). Knowledge of malocclusion supports comprehensive dental hygiene care. Canadian Journal of Dental Hygiene, 53(2), 118-124.
7. Curzon, M. E. (1974). Dental implications of thumb-sucking. Pediatrics, 54(2), 196-200.
8. Devi, L. B., Keisam, A., & Singh, H. P. (2022). Malocclusion and occlusal traits among dental and nursing students of Seven North-East states of India. Journal of Oral Biology and Craniofacial Research, 12(1), 86-89.
9. Ellis, E., & McNamara, J. A. (1984). Components of adult Class III malocclusion. Journal of Oral and Maxillofacial Surgery, 42(5), 295-305.
10. Elsherif, N., Rodriguez, J., & Ahmed, F. (2022). Prevalence and management of patients with hypodontia: A cross-sectional study. Journal of Orthodontics, 49(3), 332-337.
11. Foucart, J. M., Felizardo, R., Pizelle, C., &Bourriau, J. (2012). [Indications for radiography in orthodontics and dentofacial orthopedics]. L'Orthodontiefrancaise, 83(1), 59-72.
12. Ghodasra, R., & Brizuela, M. (2023). Orthodontics, Malocclusion. In StatPearls. StatPearls Publishing.
13. Hershfeld, J. J. (1979). Edward H. Angle and the malocclusion of the teeth. Bulletin of the History of Dentistry, 27(2), 79-84.
14. Huh, H. H., Chaudhry, K., Stevens, R., & Subramani, K. (2021). Practice of lingual orthodontics and practitioners' opinion and experience with lingual braces in the United States. Journal of Clinical and Experimental Dentistry, 13(8), e789-e794.
15. Jain, S., Debbarma, S., & Prasad, S. V. (2019). Prevalence of impacted third molars among orthodontic patients in different malocclusions. Indian Journal of Dental Research, 30(2), 238-242.
16. Karabel, M. A., Doğru, M., Doğru, A., Karadede, M. İ., & Tuncer, M. C. (2021). Evaluation of the effects of diode laser application on experimental orthodontic tooth movements in rats. Histopathological analysis. Acta Cirurgica Brasileira, 35(12), e351204.
17. Ke, Y., Zhu, Y., & Zhu, M. (2019). A comparison of treatment effectiveness between clear aligner and fixed appliance therapies. BMC Oral Health, 19(1), 24.
18. Kozanecka, A., Sarul, M., Kawala, B., &Antoszewska-Smith, J. (2016). Objectification of Orthodontic Treatment Needs: Does the Classification of Malocclusions or a History of Orthodontic Treatment Matter?. Advances in Clinical and Experimental Medicine, 25(6), 1303-1312.

19. Lagorsse, A., &Gebeile-Chauty, S. (2018). [Does gender make a difference in orthodontics? A literature review]. L'Orthodontiefrancaise, 89(2), 157-168.
20. Machado, G. L. (2015). CBCT imaging - A boon to orthodontics. Saudi Dental Journal, 27(1), 12-21.
21. Manosudprasit, A., Haghi, A., Allareddy, V., & Masoud, M. I. (2017). Diagnosis and treatment planning of orthodontic patients with 3-dimensional dentofacial records. American Journal of Orthodontics and Dentofacial Orthopedics, 151(6), 1083-1091.
22. Masucci, C., Oueiss, A., Maniere-Ezvan, A., Orthlieb, J. D., & Casazza, E. (2020). [What is a malocclusion?]. L'Orthodontiefrancaise, 91(1-2), 57-67.
23. Proffit, W. R., Fields, H. W., & Moray, L. J. (1998). Prevalence of malocclusion and orthodontic treatment need in the United States: estimates from the NHANES III survey. The International Journal of Adult Orthodontics and Orthognathic Surgery, 13(2), 97-106.
24. Rapeepattana, S., Thearmontree, A., &Suntornlohanakul, S. (2019). Etiology of Malocclusion and Dominant Orthodontic Problems in Mixed Dentition: A Cross-sectional Study in a Group of Thai Children Aged 8-9 Years. Journal of International Society of Preventive & Community Dentistry, 9(4), 383-389.
25. Recen, D., Yildirim, B., Othman, E., Comlekoglu, E., & Aras, I. (2021). Bond strength of metal brackets to feldspathic ceramic treated with different surface conditioning methods: an in vitro study. European Oral Research, 55(1), 1-7.
26. Rosa, E. P., Murakami-Malaquias-Silva, F., Schalch, T. O., Teixeira, D. B., Horliana, R. F., Tortamano, A., ... &Bussadori, S. K. (2020). Efficacy of photodynamic therapy and periodontal treatment in patients with gingivitis and fixed orthodontic appliances: Protocol of randomized, controlled, double-blind study. Medicine, 99(14), e19429.
27. Ruhl, C. M., Bellian, K. T., Van Meter, B. H., Hoard, M. A., & Pham, C. D. (1994). Diagnosis, complications, and treatment of dentoskeletal malocclusion. The American Journal of Emergency Medicine, 12(1), 98-104.
28. Staufert Gutierrez, D., &Carugno, P. (2023). Thumb Sucking. In StatPearls. StatPearls Publishing.
29. Tanna, N. K., AlMuzaini, A. A., &Mupparapu, M. (2021). Imaging in Orthodontics. Dental Clinics of North America, 65(3), 623-641.
30. Thomas, M. (2015). Orthodontics in the "Art" of Aesthetics. International Journal of Orthodontics (Milwaukee, Wis.), 26(4), 23-28.
31. Uzuner, F. D., Aslan, B. I., & Dinçer, M. (2019). Dentoskeletal morphology in adults with Class I, Class II Division 1, or Class II Division 2 malocclusion with increased overbite. American Journal of Orthodontics and Dentofacial Orthopedics, 156(2), 248-256.e2.
32. Vlachos, C. C. (1995). Occlusal principles in orthodontics. Dental Clinics of North America, 39(2), 363-378.
33. Xue, F., Wong, R. W., & Rabie, A. B. (2010). Genes, genetics, and Class III malocclusion. Orthodontics & Craniofacial Research, 13(2), 69-74.