Etiology and Treatment Modalities of Anterior Open Bite Malocclusion

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The complexity of anterior open bite is attributed to a combination of skeletal, dental, soft tissue, and habitual factors. Multiple treatment strategies aimed at different etiologies of anterior open bite have been proposed. However, the tendency toward relapse after conventional or surgical orthodontic treatment has been indicated. Therefore, anterior open bite is considered one of the most challenging dentofacial deformities to treat. The aim of this article is to review the etiologies, dentofacial morphology, treatment modalities, retention, and stability of anterior open bite. The etiology of anterior open bite malocclusions is multifactorial and numerous theories have been proposed, including genetic, anatomic and environmental factors. The diagnosis and treatment modalities are variable according to the etiology. Failure of tongue posture adaptation subsequent to orthodontic and/or surgical treatment might be the primary reason for relapse of anterior open bite. Prolonged retention with fixed or removable retainers is advisable and necessary in most cases of open bite treatment. The treatment of anterior open bite remains a tough challenge to the clinician; careful diagnosis and timely intervention with proper treatment modalities and appliance selection will improve the treatment outcomes and long-term stability.

1. Introduction

Anterior open bite is defined as no contact and vertical overlap between the maxillary and mandibular incisors.1,2 The incidence of anterior open bite ranges from 1.5% to 11% and varies between races and with dental age.3 The complexity of anterior open bite is attributed to a combination of skeletal, dental, soft tissue, and habitual factors.4 Multiple treatment strategies aimed at different etiologies of anterior open bite have been proposed. However, there is a tendency toward relapse after conventional or surgical orthodontic treatment.5,6 Therefore, anterior open bite is considered one of the most challenging dentofacial deformities to treat due to difficulties in determining the causes, formulating a diagnosis and the potential for relapse after treatment.5 The aim of this article is to review the etiologies, dentofacial morphology, treatment modalities, retention, and stability of anterior open bite.

2. Etiology

Open bites are generally classified as either skeletal or dental. The dental open bite is generally found in the anterior region within the area of the cuspids and incisors and is associated with normal craniofacial pattern, proclined and undererupted anterior teeth, and thumb or finger sucking habits. The skeletal open bite is often related to excessive vertical growth of the dento-alveolar complex, especially in the posterior molar region. As anterior open bite is often the result of a combination of both factors, it makes classification of open bite as either skeletal or dental difficult. Therefore, it has been suggested that the most clinically useful classification of open bites should be based on etiology. The etiology of anterior open bite malocclusions is multifactorial and numerous theories, including genetic, anatomic, and environmental factors, have been proposed.

3. Genetic and anatomic factors

An anterior open bite is related primarily to the patients’ unfavorable growth potential and heredity.7–9 Obtaining a thorough family history will help the clinician predict a patient’s growth pattern. Based on cephalometric analyses, the steepness of the mandibular plane is considered the key skeletal finding associated with a skeletal anterior open bite. An increased gonial angle, a downward and
backward position of the mandibular ramus, and shortened posterior facial height are additive in the production of the high mandibular plane angle in an open bite population.10 It has been suggested that the overbite depth indicator (ODI) index can be a good predictor in the primary dentition of a skeletal open bite tendency in the adolescent. The ODI is the arithmetic sum of the angle of the A—B plane to the mandibular plane and the angle of the Palatal plane to Frankfort horizontal plane. The study produced a norm of 74.5°, with a standard deviation of 6.07°.11 A value of 68° or less indicates a skeletal open bite tendency.12 Another useful method to help predict vertical growth patterns is based Nahoum's diagnosis on the ratio of upper anterior facial height to lower anterior facial height (AUFH:ALFH). If a patient has an open bite and a AUFH:ALFH ratio of less than 0.65, then the open bite is considered skeletal which cannot be corrected by orthodontic treatment alone.13 Anatomic conditions such as tongue size and position are well known to affect skeletal and dental components.14 Macroglossia has been suggested as a possible cause of open bite.15 It has been reported that in patients with anterior open bite, there are significant correlations between mandibular plane angle, ramus height of the mandible, or anteroposterior dimension of the maxilla and movement of the front part of the dorsal tongue during deglutition.16 Some anatomic conditions such as enlarged adenoids, tonsils, or tonsils, swollen nasal turbinates, and deviated nasal septums may impair normal upper respiratory nasal function.17 Mouth-breathing or a reverse airway obstruction may cause anterior open bite but their direct relationship has not been proven.18 Mandibular condylar resorption has also been identified as an etiologic factor of anterior open bite. Many local and systemic pathologies or diseases can cause mandibular condylar resorption. Local factors include osteoarthritis, reactive arthritis, avascular necrosis, infection, and traumatic injuries. Systemic connective tissue or autoimmune diseases that can cause condylar resorption include rheumatoid arthritis, psoriatic arthritis, scleroderma, systemic lupus erythematosus, Sjögren syndrome, ankylosing spondylitis, etc.19

4. Environmental factors

Various habits such as thumb and finger sucking, forward tongue posture, as well as tongue thrust have been reported as causative factors.20–22 Digit sucking can lead to an asymmetrical anterior open bite which is worst on the side that the digit is sucked. Not all digit suckers develop anterior open bite, the important factors being the duration and frequency of the habit. Those who suck for more than 6 hours a day often develop significant malocclusions. A forward tongue posture, where the tongue rests between the incisors, may obstruct incisor eruption and lead to the development of an anterior open bite. This should not be confused with a secondary adaptive tongue thrust, in which the tongue moves forward during swallowing to contact the lips and form an anterior oral seal secondary to an anterior open bite. A diagnostic feature on the lateral cephalogram suggesting forward tongue posture is the presence of a reverse curve of Spee in the lower arch caused by reduced incisor eruption.23 Neuromuscular deficiencies also contribute to the skeletal characteristics of an open bite.24,25 Patients with generalized pathology of muscle such as muscular dystrophy maybe more prone to an increased vertical dimension and anterior open bite.26 A reduction in the force of contraction of the muscles of mastication, at rest and during function, may lead to excessive vertical skeletal growth and molar overeruption.

5. Dentofacial morphology

Many analyses comparing control samples to subjects with skeletal open bite have shown no significant difference in the anterior cranial base as measured from sella to nasion, in the cranial base angle (N—S—Ba).27 Richardson also suggested that there is no significant difference in the cranial base as measured either from sella to nasion or from sella to basion.28 However, Subtelny suggested that the distance between sella and basion is less in their open bite samples.9

There is agreement among the many investigators who have studied skeletal open bite that the mandibular plane angle is consistently larger in skeletal open bite patients than in controls. The high mandibular plane angle is found in open bite patients due to a significantly shorter mandibular ramus, as well as an opening rotation of the mandibular ramus.9,29,30 An increased gonial angle, a downward and backward posture of the mandibular ramus, and shortened posterior facial height are additive in the production of the high mandibular plane angle in an open bite population.10 When the total gonial angle (TGA) is divided by the line N—Go into two parts, the upper part is termed the upper gonial angle (UGA) and the lower part is the lower gonial angle (LGA). According to Siriwat and Jarabak, the UGA reflects the amount of the horizontal vector of the facial growth, and the LGA reflects that of the vertical vector.30

The anterior total facial height (ATFH) is greater than that in a normal population, and the posterior facial height (PFH), the distance between sella and gonion, is usually shorter in anterior open bite patients than in normal individuals.9,29,31,32 In some previous studies, the ALFH has been considered abnormally larger than usual, while the AUFH remained normal, which entailed smaller ratios of PFH:ATFH and AUFH:ALFH in anterior open bite patients.13,29,32

An increase in posterior maxillary dento-alveolar height is commonly mentioned in open bite cases.9,29,33,34 and that an overeruption of the mandibular molar teeth causes an opening rotation of the mandible is also mentioned.27 However, no significant differences in posterior maxillary dento-alveolar height and overeruption of the mandibular molar between open bite and normal samples have been noted.9,32

6. Treatment modalities

Treatment of anterior open bite is a great challenge in orthodontics, and several approaches have been addressed. Following treatment, patients can benefit from improved ability to incise and chew food, improved esthetics, and improved speech. However, it must be kept in mind that treatment strategies should always address the etiology of the malocclusion.

It is common for children to have a finger or thumb habit and they should be encouraged by their parents to stop their habit before the age of 6 years for creating a favorable environment for the eruption of permanent teeth. Therefore, it is important that habits are terminated before commencing orthodontic treatment. If initial attempts are unsuccessful, an intra-oral appliance with loops that acts as a mechanical obstruction and reminder may be given. Tongue thrusting can also adversely affect the teeth and mouth. Tongue crib use has been shown to modify tongue behavior and were effective in closing open bite when worn for a minimum of 1 year.13,35 Myofunctional therapy is also useful in muscle retraining by using a series of tongue exercises to correct the deleterious resting and functional posture.35 Mastication exercises in conjunction with concentrated vertical control seemed to reduce aberrant vertical growth patterns in patients, particularly those suffering from neuromuscular deficiencies.36 Patients were instructed to clench on a soft bite wafer (GAC International, Bohemia, NY) for 1 minute, five times a day. Each 1-minute session included 5 seconds of isometric clenching (80% of maximum), followed by 5 seconds of rest. This cycle was repeated six times, for a total of 1 minute.36
Tongue size and position affect skeletal and dental components, and macroglossia has been suggested as a possible cause of open bite and mandibular prognathism. Bernard and Simard-Savoie have performed a medial glossectomy on a monkey with open bite and the postsurgical observation of 52 months indicated a steady increase of over bite. Hence, reduction of tongue mass by partial glossectomy is an effective treatment for correcting open bite with macroglossia.

Because the direct relationship between anterior open bite and mouth-breathing as a result of chronic respiratory obstruction has not been proven, prolonged mouth breathing may not necessarily be the main etiological factor for malocclusion. Therefore, diagnosis of upper airway obstruction should be made by an appropriate team of specialists and the decision for surgical intervention such as adenoidectomy or tonsillectomy is not recommended in the prevention of malocclusion and should be done for medical purposes only.

The treatment of skeletal open bites varies between growing and adult patients. Treatment modalities in growing patients with skeletal open bites are geared towards vertical growth modification. In adult patients, the options are more limited, and often involve an orthognathic surgery. The overall goal of treatment in growing patients is to reposition the occlusal plane downward and backward and correct the malocclusion. Several methods have been proposed for controlling vertical growth. The vertical holding appliance (VHA) is a modified transpalatal arch that has an acrylic pad. The VHA uses tongue pressure to reduce the vertical dentoalveolar development of maxillary permanent first molars. Posterior bite blocks impede posterior teeth eruption and studies have suggested that posterior bite blocks modify the vertical skeletal pattern effectively. They can be made of wire or plastic to fit between the maxillary and mandibular teeth, or they can be spring-loaded or fitted with magnets. In correcting skeletal open bite problems, functional appliances, such as activators, bionators, and Fränkel regulators (most with the inclusion of posterior bite blocks), have been used to control vertical maxillary growth of the mixed dentition. A bionator can be used to treat open bite problems, especially if accompanied by a class II molar relationship. Fränkel IV regulator was introduced and evaluated by Fränkel among patients with a hyperdivergent skeletal pattern. Fränkel believed that changes of the vertical components may have resulted from lip-seal training, with the function regulator acting as an exercise device and leading to postural balance between the forward and backward rotating muscles. Another appliance approach uses extra-oral devices, such as high-pull headgear, to impede the vertical skeletal and dental growth pattern. Schudy and Brandt have advocated a high-pull headgear along with a mandibular splint covering the second molars and anterior vertical elastics to treat open bites. Ngan et al. demonstrated that open bite complicated by a class II vertical growth pattern can be treated during the mixed dentition with favorable results by using a combination of an activator and high-pull headgear. The vertical chin cup, together with fixed appliances, has also been used to manage anterior open bite in growing patients by controlling the vertical growth. In a single case report, Pearson reported that the use of a vertical-pull chin cup could result in a decrease in mandibular plane angle and an increase in posterior facial height.

Some mild cases of open bite can be corrected by fixed appliances that only allow dental movements in a camouflage method of treatment. However, the skeletal profile and characteristics are kept unchanged. Various extraction modalities have been suggested to correct anterior open bite, which aim to extrude the anterior segment by the draw-bridge effect of reducing the inclination of both upper and lower incisors to increase over bite and move the posterior teeth anteriorly by the wedge effect, or a combination of the two. These extraction strategies include extracting the second molars, first molars, second premolars, or first premolars. Extrusion of the upper and lower incisors is another common orthodontic modality for anterior open bite by using vertical elastics, extrusion arches, or a multiloop edgewise archwire (MEAW) appliance. However, correction of the malocclusion by extrusion of the upper incisors may result in an excessive display of the incisors and gingival tissues, especially in patients with anterior vertical maxillary excess. Thus, care must be taken not to erupt the teeth extensively when the patient has increased facial height. Molar intrusion for correction of anterior open bites was challenging to orthodontists before the development of skeletal anchorage. Skeletal anchorage, including dental implants, surgical miniplates, and miniscREW or microscrew implants, are now growing in popularity due to their ability to provide absolute anchorage. The intrusion of molars with skeletal anchorage produces counterclockwise rotation of the mandible and decrease of the overbite.

Orthognathic surgery is often indicated for many non-growing patients, particularly for esthetic needs, considerable open bite, or skeletal problems in multiple planes of space. The surgical approaches include maxillary or mandible surgeries, surgery on both maxilla and mandible, anterior maxillary surgery, and mandibular surgery. Mandibular surgeries and mandibular surgeries combined with temporary anchorage devices (TADs) are now growing in popularity due to their ability to provide absolute anchorage. The intrusion of molars with skeletal anchorage allows auto-rotation of the mandible, therefore decreasing the lower face height and eliminating anterior open bite. Closing rotation of the mandible using rigid fixation is a viable surgical option for the correction of anterior open bite in instances in which maxillary osteotomies are not indicated to improve facial esthetics. However, closing rotation of the mandible with only mandibular surgery has been shown to be highly unstable because it lengthens the ramosus and stretches the muscles of the pterygomandibular sling. Therefore, a two-jaw surgery involving superior repositioning of the maxilla with a Le Fort I osteotomy is recommended to obtain more stable and predictable results for the surgical correction of skeletal open bite. Mandibular surgeries combined with TADs resolves the high level of surgical invasion and the possibility of alar flaring caused by superior repositioning of the maxilla.

7. Retention and stability

The importance of retention is to enhance stability, especially by eliminating the cause of the open bite. Studies of long-term results of open bite orthodontic treatment by Lopez-Gavito et al. and surgically treated cases by Denison et al. indicate that the relapse rate can range from 35% to 42.9%. Relapse after anterior open bite treatment has been attributed to tongue posture, growth pattern, treatment parameters, and surgical fragment instability, possibly due to increased facial height and extrusion of maxillary molars. Surgical procedures, fixation type, and maxillary transverse relapse can be associated with open bite relapse. With regard to the surgical procedures, greater over bite stability can be achieved with maxillary surgical repositioning only, or with bimaxillary surgery, whereas mandibular surgery only produces less stable results. Failure of tongue posture adaptation subsequent to orthodontic and/or surgical treatment might be the primary reason for relapse of anterior open bite. The relative increase in tongue volume in the oral cavity would also cause a relapse of the mandibular position after the mandibular setback, resulting in a decrease in overjet and overbite. Myofunctional therapy and placement of a tongue crib may improve stability in patients.
especially with an anterior tongue rest posture. Clinicians attempt to maintain the corrected open bite for growing patients by applying a vertical chin cup or high-pull headgear to the upper molars in conjunction with a standard removable retainer. Retainers with occlusal coverage to prevent further molar extrusions, and wearing conventional retainers in the daytime, combined with wearing a functional appliance with bite blocks (an open bite activator or a bionator) at night time can also be used. Some clinicians even suggested that prolonged retention with fixed or removable retainers is advisable and necessary in most cases of open bite treatment.

References
