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A Review Article on Diagnosis and Treatment Planning of Openbite Malocclusion

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Abstract

The vertical dimension of the face has been the most difficult to modify clinically.Problems in the vertical dimension include open bite and deep bite malocclusions and also facial disfigurations.Vertical malocclusions and disfigurations result from the interaction of many different etiological factors. Vertical growthis the last dimensionto be completed, therefore treatment mayappearto be successful at one point and fail later. Sometreatment maybe prolonged, if begun early. Long-termclinical outcomesare neededto determinetreatment effectiveness and clinicians should considerthe cost-effectiveness of these early initiated and protracted plans.

Keywords: Lip seal exercise, Thumb contract, Airway obstruction, Adenoid facies, Long face syndrome,Soft tissue stretching theory, The Active Vertical Corrector, Multiloop edgewise appliance

Introduction

Open bite was defined by Subtelney and Sakuda as open vertical dimension between the incisal edges of the maxillary and mandibular anterior teeth, although loss of vertical dental contact can occur between the anterior or the buccal segment. The problem of open bite is multifactorial. Diagnosis should be viewed in the context of the skeletal structure and the dental structure. [4]

Studies of open bite have implicated many potential causes, including

1. faulty postural performance of the associated musculature
2. digit sucking habits
3. tongue activity
4. lymphatic tissue
5. obstructed naso-respiratory function
6. unfavorable growth patterns
7. imbalances between jaw posture
8. occlusal and eruptive forces
9. Heredity

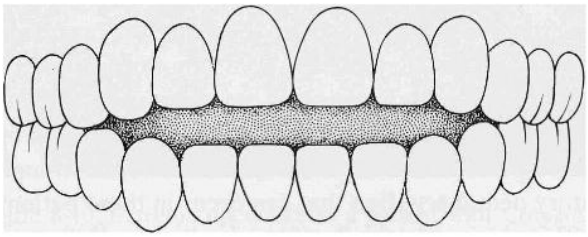
Definition

The Glossary of Orthodontic Terms defines open bite as a developmental or acquired malocclusion whereby no vertical overlap exists between maxillary and mandibular anterior teeth (anterior open bite) or posterior teeth (posterior open bite)

Overview of Openbite

Posterior open bite is caused by tongue interposition or by disturbances in eruption (e.g. ankylosis). Posterior open bites rarely are due to primary failure of eruption. Defects in eruption often are associated with various craniofacial syndromes, including cleidocranial dysplasia and Carpenter's syndrome. [1]

Figure 1:



Open bite without facial disfiguration is classified as a dental open bite and frequently is associated with a digital sucking habit and/or tongue interposition. The characteristics of a dental open bite include problems typically restricted to the anterior teeth and immediately associated hard and soft tissue without remarkable cephalometric findings.The characteristics of a skeletal open bite occur throughout the craniofacial region.Short mandibular ramus and a downward rotation of the posterior part of the maxilla.These relationships lead to a downward and backward rotation of the mandible, relative mandibular retrognathia, and anterior open bite.[1]

According to Proffit about one-third of patients with long-face syndrome have normal or excessive overbite, rather than an open bite.This observation illustrates that the long face syndrome and the dental open bite are different entities; however, in most cases, skeletal open bite is combined with dental open bite.Magnetic resonance imaging (MRI) studies revealed that the size of the jaw muscles in long face subjects was up to 30% smaller than in normal individuals, whereas the position of the muscles was comparable in both groups. Maximum bite force in long face subjects was roughly half that in normal subjects.[10]

Factors related to the development of vertical skeletal dysplasias

1. Growth
2. Remodeling
3. Rotation of the mandible and maxilla during growth.

Mandibular Development

One of the key factors associated with the development of open bite malocclusions is the pattern of the growth of the mandible. The implant studies of Bjorkshown that the direction of mandibular growth varies greatly. Mostly the direction of condylar growth is superior with some anterior component. A posteriorly directed vector of growth is observed less frequently. The vertical growth of the face is related closely to mandibular growth rotation. These differences in facial heights are associated with rotational growth or positional changes of the mandible that affect chin position.Factors that determine the increase in lower anterior facial height include the eruption of the maxillary and mandibular

posterior teeth and the amount of sutural lowering of the maxilla. Posterior facial height is determined by condylar growth as well as by a slight lowering of the temporal fossa.Vertical condylar growth that exceeds the amount of vertical tooth eruption is associated with forward rotation of the mandible.On the other hand, tooth eruption that exceeds vertical condylar growth is associated with downward and backward mandibular rotation.[6]

Schudy has suggested that the inclination of the mandibular plane is a good indicator of mandibular rotation. For example, a small mandibular plane angle (MPA) indicates that the mandible had rotated forward. [5]

Maxillary Development

According to Lavergne and Gasson, if the posterior part of the maxilla rotates downward posteriorly or upward anteriorly, space for the eruption of the posterior teeth is reduced, space for the eruption of the maxillary anterior teeth increases, and there is a tendency toward an anterior open bite. Conversely, if the anterior part of the maxilla rotates in a downward direction, a deep bite anteriorly may result. [11]

Role of Soft Tissue

According to Angle certain types of malocclusions was caused by forces on the teeth resulting from an improper soft tissue environment.During the 1950s and 1960s, clinicians popularized the idea that open bite was caused by tongue thrusting and abnormal swallowing habits. Treatment approaches to open bite were aimed at retraining or restricting the action of the tongue. [2]

Proffit and Mason reported a poor correlation between tongue thrust and open bite malocclusion.The research of Proffit demonstrated that phasic activities such as swallowing, chewing, and speaking have no impact on the morphology of the dentition.Conversely, postural alterations leading to changes in lip and tongue resting pressure and posture play a significant role. There is a threshold duration of 4-8 hours per day, below which force has no effect on tooth position. On the other hand, resting pressures apparently have an effect, even if the forces are light. Proffit has stressed, that resting pressures rarely are perfectly balanced, and "active stabilization" from metabolic activity in the periodontal ligament probably plays a role in maintaining equilibrium of forces in the orofacial region, particularly regarding the positions of the anterior teeth.Proffit also described the forces contributing to vertical equilibrium. [10]

Proffit concluded that short-lasting activities as speech, swallowing, and chewing have no impact on the morphology of the dentition, but that posture and resting pressure are of great clinical significance. Nevertheless, clinicians do not seem to accept the consequences of these conclusions and much emphasis still is placed on "tongue thrust." Tongue thrust has to be considered as a secondary phenomenon that provides seal of the oral cavity, essential for the swallowing conditions of anterior open bite.Therefore, the "tongue thrust" is adaptive, not causal. [10]

Tongue-inhibiting appliances were developed to counteract the forward movement of the tongue during function, including tongue-restraining devices. Graber reported an initial 92% success rate with palatal crib treatment, but the occlusions of many patients relapsed following the removal of the "tongue habit appliance''.Frankel examined patients who had relapsed following tongue crib treatment.Frankel first assumed that the relapse was due to too short of a treatment duration to "reeducate" tongue behavior, but he found that occlusal relapse occurred even after renewed treatment with the palatal crib appliance. In general,

attempts to change the resting position of the tongue have met with little success.[18]

Ballard, in 1965 advocated paying more attention to the size and shape of the lips when evaluating habit behaviors. Ballard stated that too much emphasis was being placed on the role of tongue thrust in open bite malocclusions. He felt that the anterior postural position of the tongue appeared to compensate for the lack of an anterior oral seal formed by lip. Indeed, if a proper lip seal is not maintained during normal functional activities, the tongue serves to seal the oral cavity through an adaptive change in postural position.Frankel's approach to the treatment of anterior open bite differs from that of Ballard, in that Ballard thought that lip incompetence was a consequence of a discrepancy between skeletal and soft tissue growth. Frankel, concluded that an absence of competent oral seal was due to lack of adequate postural activity of the facial musculature, particularly lip-valve musculature and advocated lip seal exercises. He instituted functional therapy with vestibular shields and lip seal training for anterior open bite patients. Frankel observed that a normal overbite was obtained and remained stable, providing that a competent anterior oral seal also was established and maintained. Frankel's therapeutic strategy was aimed at the establishment of a normal pattern of nasal breathing by correcting the lips-apart condition and faulty tongue posture. [1 19]

Influence of Nasorespiratory Function

One proposed cause of vertical dysplasia is deviating neuromuscular function associated with an abnormal breathing pattern. Physiologic adaptations to various types of upper respiratory obstruction (e.g., constricted external nares, deviated septum, nasal polyps, enlarged adenoids, enlarged tonsils) initially may lead to altered functional activity of the muscles associated with respiration. Change in the level of postural activity of craniofacial muscles lead to a change in craniofacial morphology, particularly in the vertical dimension. [20]

Solow and Kreiborg have proposed the soft tissue stretching theory, which postulates a relationship between airway obstruction and head posture relative to the cervical spine.Changes in the level of activity of certain craniofacial muscles leads to extension of the head for airway maintenance which causes a stretching of the masticatory and facial muscles as well as the associated soft tissue. A prolonged obstruction of the airway can lead to skeletal remodeling and ultimately a change in craniofacial morphology.The classic clinical example of the possible relationship between airway obstruction and aberrant craniofacial growth is the type of patient described as having "adenoid facies". [15]

Adenoid facies

1. mouth-open posture
2. small nose with button-like tip
3. nostrils that are small and poorly developed
4. short upper lip
5. prominent maxillary incisors
6. vacant facial expression.

Nasorespiratory Physiology

When nasal airway is obstructed, respiratory system responds with compensations to maintain an optimal level of air intake. Oral posture depends on the status of the nasal airway. When the cross-sectional area of the airway at its narrowest point is approximately 25% of the normal size, airflow is reduced significantly, and the nose can be considered severely obstructed.There is no direct correlation between airway obstruction and mode of breathing. E.g. an individual with an open mouth posture is not necessarily a mouth breather.Johnston and Rubin have stated that mouth-breathing does not in itself cause altered facial growth.Rather, mouth breathing may

cause habitual mouth open posture, a proximal cause of long face syndrome.Posterior crossbite may occur because the tongue is lowered, leaving the constricting effect of the buccinator musculature unopposed. [12]

Experimental Studies of Respiratory Obstruction

In experimental studies conducted by Harvold & Miller, latex plugs were inserted into the nasal openings of young rhesus monkeys.The first noticeable changes were functional in nature, in that the animals altered their patterns of neuromuscular activity in order to accomplish oral breathing.Individual monkeys met this challenge in different ways. Some of the animals learned to posture their mandible with a downward and backward (retrusive) opening rotation. Dental eruption and vertical posterior alveolar growth are enhanced because the forces restraining these changes are reduced due to the chronic mouth open posture.Adenoid facies and a steep mandibular plane are frequent findings in patients with upper respiratory obstruction. Some rhythmically lowered and raised their mandibles with each breath. Still others postured their jaw in a downward and forward (protrusive) position, but each in its own way managed to breathe through its mouth. Those animals augmenting the oral airway by pointing the tongue in a forward position also developed a moderate change in mandibular shape. The tongue itself became long and thin, and an anterior open bite developed. [21] [22]

Conclusions

All animals did not adapt functionally in the same way and they depended on the unique neuromuscular adaptation of the individual animal.

Clinical Studies on Respiratory Obstruction

Angle included airway obstruction as an important etiological factor in Class II malocclusion.Ketcham recommended that patients see the rhinologist as well as the orthodontist. [2]

Linder-Aronson and Backstrom compared facial type and type of occlusion in nose breathers and habitual mouth breathers. They noted that children with long narrow faces have greater nasal resistance than those with short, wide faces. No direct relationship between mouth breathing and type of occlusion could be found, particularly with regard to overbite and overjet.Linder-Aronson noted that the mouth-breathing individuals continued to have a significantly higher nasal resistance even after the use of nose drops. In both studies, variations in palatal height were notably greater in the mouth-breathing group than in the nose-breathing group.These studies indicate that there is a relationship between upper respiratory obstruction and the configuration of the craniofacial structures of a given individual, but that there is no one specific pattern that can be correlated directly with mouth breathing. [3]

Airway Parameters and Facial Form

The relationship between airway parameters and facial form remains unclear. Woodside and co-workers assessed nasal obstruction in children by rhinomanometry immediately post-adenoidectomy and five years post-adenoidectomy. During five-year post-treatment interval, there was a small but statistically significant increase in the amount of mandibular growth in children who had undergone adenoidectomy than in a control group. [29]

Ung and co-workers found that, over a 24-hour period, subjects varied in their mode of breathing. Lip posture also has been used as a method of assessing airway resistance indirectly. Individuals who have a more open lip posture also have increased nasal airway resistance. Children who have a more open lip posture also have larger mandibular and palatal plane angles, decreased

maxillary growth and increased lower anterior facial height. [28]

According to Trotman and co-workers reduced sagittal airway size was associated with a backward relocation of the maxilla and mandible. Because the sella-nasion dimension shortened proportionately, the SNA and SNB angles were not affected. Larger tonsils, on the other hand, were associated with a forward relocation and rotation of the maxilla and mandible and increased SNA and SNB angles. Trotman and co-workers concluded that lip posture, sagittal airway size, and tonsil size represent three different and unrelated phenomena with respect to their effects on craniofacial growth and form. [31]

Linder-Aronson-followed 41 children who had undergone adenoidectomies for a period of five years postoperatively. The thirty-four children who had switched post-operatively from oral breathing to nasal breathing were compared to 54 normal children. The significant group mean differences found initially between the dentitions and facial skeletons of the operated and control children tended to disappear during the postoperative years. The greatest changes occurred in the dentition and nasopharynx during the first postoperative year. [7]

Treatment of Openbite

Suggested treatment for open bite malocclusions covers a broad spectrum that ranges from behavior modification to orthodontic, orthopedic, and surgical interventions.

Lip Seal Exercises

In patients with lip incompetence, lip seal exercises are an integral part of Frankel therapy, and can be incorporated successfully into routine treatments. It can be initiated without orthodontic intervention, as an attempt to improve facial balance and soft & hard tissue esthetics and function. These exercises establish normal neuromuscular function, as well as a pattern of nasal rather than oral breathing.The patient is instructed to keep the lips together at all times, thus nasal respiration is encouraged. Patients often are given some type of reminder sticker. These types of reminders are useful in encouraging lip closure. While a child is watching television or reading, the child be given some type of small object to be kept between the lips like plastic disks, Popsicle TM sticks, and toothpicks.Patients who are candidates for this type of exercise often have mentalis hyperactivity also. The patient can be instructed to press on the muscle with a finger.This exercise can be performed inconspicuously. Lip seal training can be initiated immediately, even at the time of the initial examination. [18]

Elimination of Digital Habits

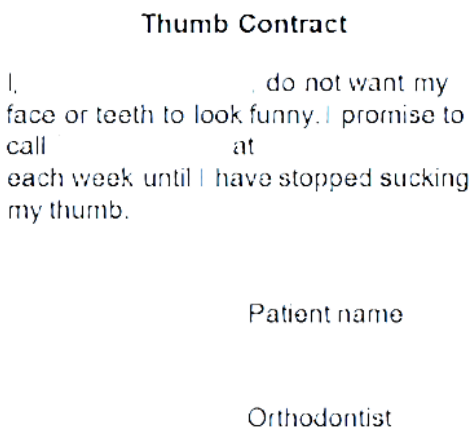
Digital habits have been associated with the formation and maintenance of anterior open bite.

Therapeutic possibilities for elimination of digit habits

1. Digit inhibiting appliances eg. tongue crib.
2. Painting a foul-tasting or annoying substance (e.g., hot pepper solution) on the offending digit
3. Covering the hand with a sock during sleeping hours

One of the simplest yet most effective behavior modification strategies is the "thumb contract". Usually, digital sucking habit is identified during the initial examination through history taking. If a sucking habit is denied by the patient, clean digit with callous formation can expose the patient. The orthodontist initiates discussion with the young patient about the detrimental effects of the digital sucking habit, with examples of long-term effects of such habit. [1]

Figure 2:



The patient is asked to sign a written contract with the orthodontist not to suck the thumb or finger for one week. Typically, if a patient wants to stop the habit, the thumb contract with the orthodontist provides enough incentive to terminate the habit.The child is instructed to call the orthodontist personally each week until success is achieved.This technique was used over 20 years and estimate our rate of success at about 75%. [1]

Conventional Orthodontic Treatment

Nahoum stated that degree of success with conventional orthodontic procedures is inversely proportional to the extent of the skeletal dysplasia and to the number of teeth involved in the open bite. The rate of success diminishes as the open bite extends laterally and posteriorly into the canine, premolar, and molar regions.Proffit stated that successful treatment of skeletal open bite in a growing patient requires control of the downward growth of the maxilla as well as control of the eruption of the posterior teeth, so that further mandibular rotation is prevented. Such effects are extremely difficult to achieve and continued vertical growth in the late teen years can undo the outcome of orthodontic treatment and can lead to the need for a surgical correction. [10]

Non-Surgical Treatment Approaches to Open Bite

The treatment approach required the use of vertical intermaxillary elastics in an effort to bring the anterior teeth together.This mode of treatment has not always led to a sufficient correction or a stable long-term occlusal result. The extraction of posterior teeth, especially of second molars, also has been suggested as a method of producing bite closure anteriorly.In instances where etiology of the open bite is not well defined, treatment approach can be aimed at controlling the vertical growth of the patient. High-pull headgear has been used often in this regard, especially when posterior vertical maxillary excess is evident. This type of treatment inhibits vertical maxillary development and permit forward rotation of the mandible, leading to closure of the bite. [1]

Van der Linden noted that, following the use of a high-pull headgear in patients with a long face, suppression of vertical development unfortunately is followed by an excessive increase in facial height in subsequent years. [24]

Functional Jaw Orthopaedics

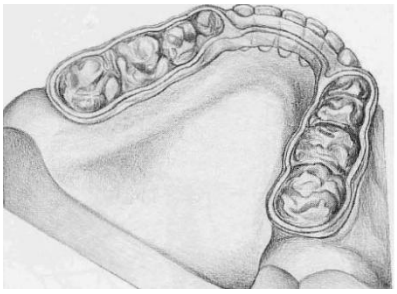
In Europe, a number of investigators have treated open bite problems with various removable appliances, with the view that they were controlling "local epigenetic factors." These appliances included the Andresen and Haupl activator, the Harvold-Woodside activator, the open bite Balters bionator and Frankel's function regulator.Frankel's approach to the treatment of skeletal open bite with the function regulator, combined with rigorous lip seal training, seems to have the greatest success in treating skeletal open bite patients. Shift in equilibrium of the soft tissues of the craniofacial complex can be obtained by orthopedic intervention. The treatment results of Erbay and co-workers with the FR-IV appliance support Frankel's approach to anterior open bite. The downward and backward growth direction of the mandible observed in the control group changed to

an upward and forward direction by FR-IV therapy. The skeletal anterior open bite was corrected successfully through upward and forward mandibular rotation. [18]

Posterior Bite Block

A logical approach to the treatment of over-erupted posterior teeth is dental intrusion. Experimental studies shown that vertical component of skeletal and dental development can be modified with posterior bite blocks.McNamara observed inhibition of molar eruption as well as a reduction in the vertical development of the maxilla in juvenile monkeys treated with posterior bite blocks. [1]

Figure 3:

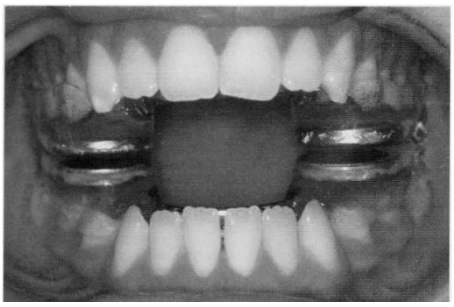


Woods & Nanda and Hoenie & McNamara- observed decreased posterior dental eruption and upward and forward positioning of the maxilla in growing primates treated with magnetic as well as passive posterior bite block appliances.In clinical practice, a number of posterior bite block designs have been suggested, including both removable and fixed types. Eruption of the posterior teeth is inhibited and slight intrusion of the posterior teeth may occur. In addition, slight extrusion of the teeth not incorporated into the expander may occur, which leads to a closure of the anterior open bite. [26]

Active Vertical Corrector

Another appliance that has received attention as a suggested alternative to orthognathic surgery is the Active Vertical Corrector™ (AVC). Dellinger introduced the AVC as an appliance that incorporated repelling samarium cobalt magnets in a posterior bite block type of appliance. Dellinger's appliance incorporated samarium magnets into acrylic posterior bite block appliances that covered the posterior dentition in both arches. [30]

Figure 4:



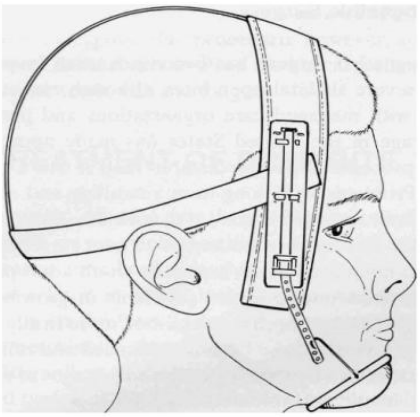
Although preliminary results appeared promising, complications were encountered.Patients had difficulty in tolerating the increased vertical dimension caused by the appliance thickness, and some of the patients shifted their mandibles laterally as the repelling magnets came together. In 1991, the design of the AVC was modified so that the height of the appliance was reduced, and buccal shields were added to eliminate lateral displacement during function.Cavanaugh and Christiansen compared the original and modified designs of the Active Vertical Corrector. They noted passive eruption of the maxillary and mandibular incisors in both appliance groups.Significant intrusion of the posterior maxillary dentition was observed with the original AVC design; significant mandibular molar intrusion did not occur in either group. Most importantly, significant skeletal changes did not occur with either AVC design. Cavanaugh and Christiansen concluded, "Magnets, as used in either the original or the revised active vertical corrector, have limited value in the treatment of open-bite malocclusion." [34]

Vertical Pull Chin Cups

Application of external forces to the dentition can lead to tooth intrusion. A patient-friendly way of creating vertically acting forces against craniofacial complex is

the chin cup. In patients who have a potential for the extrusion of posterior teeth, preventing the extrusion of teeth in the buccal segments may be helpful. Pearson and Speidel have stressed the importance of retarding the vertical growth vector of a backward rotating mandible by applying extraoral orthopedic forces with a vertical-pull chin cup. [16]

Figure 5:



Vertical-pull chin cups are applicable in Class III patients with anterior open bite tendencies and in patients who have an increased anterior vertical dimension. Pearson has reported that the use of a vertical-pull chin cup can result in a decreased mandibular plane and gonial angles and increased posterior facial height.It is very difficult to create a true vertical pull on the mandible, due to problems in anchoring the chin cup cranially. Both the occipital-pull and vertical-pull chin cups create pressure on the temporomandibular joint region.Although this type of therapy has been used successfully for decades, the clinician should monitor chin cup patients for signs of TM disorders. If any are noted, the use of the chin cup should be discontinued immediately. [16]

Orthognathic Surgery

Due to the problems with long-term retention and stability in skeletal open bite, orthodontics without surgery should not be attempted in adult patients and in moderate-to-severe problems in growing children.Surgical procedures have become advanced to the extent that they can offer the advantages of a definitive, esthetic, and stable result. [14]

Most of the surgical procedures for skeletal open bite involve:

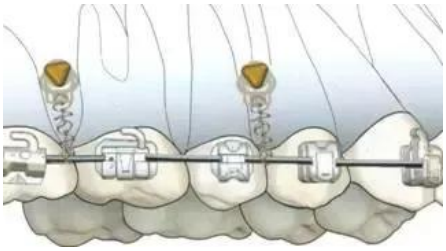
1. LeFort I osteotomy
2. sagittal split osteotomy
3. segmental osteotomies
4. genioplasties

Also, various combinations of the same have been used in the treatment of skeletal open bite.Often the treatment of skeletal open bite is postponed until growth is complete and orthognathic surgery can be performed. Evaluation of large samples of treated patients who have undergone these types of procedures reveal that the skeletal improvement generally is maintained, although a dental open bite often returns.Tongue interposition between the teeth seems to persist in spite of the surgical procedure. Another surgical treatment alternative is a partial glossectomy, the removal of excess lingual tissue.This procedure is performed when macroglossia, hypertonicity, or edema of tongue is the major etiological factor of malocclusion and re-education of tongue has failed. [14]

Mini-Implants

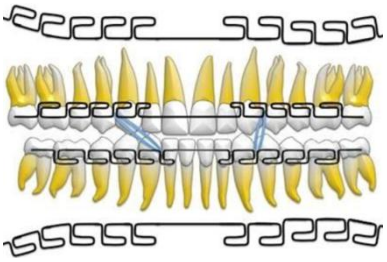
Intrusion of posterior dentition can be carried out by the use of buccal and or palatal individual implant or plates inserted in zygomatic bone or in posterior mandible. To avoid buccal rotation of teeth being intruded, a TPA connecting right and left posterior teeth are placed or the combined use of buccal and palatal implant have been advocated. [34]

Figure 6:



Sugawara et al suggested that titanium miniplates can be used as a source of rigid skeletal anchorage to facilitate intrusion of mandibular molars. When skeletal anchorage was used in tandem with multiloop edgewise appliance (MEAW), the mandibular molars could be intruded effectively with very little extrusion of incisors. [34]

Figure 7:



Summary

Many different etiological factors have been implicated in the development of hyper and hypodivergent faces. Large variations have been reported regarding the response of the growth of the face to specific etiological factors as well as to their elimination. Most likely, all these etiological factors, each in its own way, may have only a small effect, and yet these factors can interact in ways that magnify or diminish the response.Of prime importance in the management of vertical problems is the role of the musculature and the other soft tissues. Generally, the more severe the skeletal imbalance, the less effective are the non-surgical approaches to correction.Often, orthognathic surgery is the only viable option in difficult open bite and deep bite situations, associated with facial disfigurations.

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