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An insight on management of open bite

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Abstract
Open bite is one of the most common malocclusion and is most difficult to treat. It is seen when there is lack of overlap between the maxillary and mandibular teeth. It can be either Anterior open bite or Posterior open bite. General etiological factors considered to be associated with open-bite are vertical growth deficiencies, disproportionate muscle growth or aberrant muscle function, Thumb and finger-sucking habits. It can be skeletal or dental in origin. The prevalence of anterior open bite ranges from 1.5% to 11% and varies between ethnic groups and by age and dentition. Diagnosis can be done clinically and cephalometrically. Successful treatment can be achieved by addressing its underlying components. Proper retention plan should be planned as the relapse rate is high in these cases. The treatment should be planned accordingly in deciduous, mixed and permanent dentition. In this article we have discussed about various treatment modalities to treat the open bite.

Keywords: open bite, deciduous dentition, mixed dentition, permanent dentition

Introduction
Anterior open bite (AOB) [1] is defined as the lack of incisal contact between anterior teeth in centric relation. They can occur in anterior as well as posterior region and are called anterior open bite and posterior open bite respectively also there is skeletal and dental open bite. Dental open bite is because of lack of vertical development of the incisors and the alveolar component. It can be due to overeruption of posteriors or under eruption of anterior while skeletal relationships are normal and the skeletal open bite is determined by a vertical skeletal discrepancy, it results in jaw bases moving away from each other. Skeletal open bite is usually characterized by increased lower anterior facial height and increased gonial angle, short mandibular ramus, and increased posterior dentoalveolar height. Caravelli in 1842 coined the term “open bite”.

Management of Open Bite
Based on the type of dentition, it can be divided into
- Management in Deciduous dentition
- Management in Mixed dentition
- Management in Permanent dentition

Open bite correction before growth completion can be done by habit breaking appliances, functional appliances and orthopaedic appliances. After growth completion it can be treated with fixed appliance mechanotherapy and surgical approach.

Management in Deciduous Dentition
Possible etiology for anterior open bite in deciduous dentition are non-nutritive sucking habits such as finger sucking, atypical swallowing, mouth breathing, anterior positioning of tongue at rest.
It can be treated by encouraging the child to discontinue the habit and use of screening appliances. The Screening appliances intercept and eliminate all abnormal perioral muscle function in acquired malocclusions resulting from abnormal habits, mouth breathing, and nasal blockage.
No treatment should be done before 5 years of age, parents should encourage abondement of the habit by positive motivation and reward strategy.
According to Janson and Valarelli [2], before 5 years of age an attempt should be made to try eliminate the habit with exchange for toys if the child did not abandon the habit orthodontic treatment should be initiated after 5 years of age. If the child abandons the habit and bite hasn’t closed yet, orthodontic treatment has to be started after 5 years. If the bite is closed and persistent functional tongue problems are present then the child should undergo speech therapy if not, no orthodontic or speech therapy are necessary. If habit still persists after 5 years of age after the attempt to inhibit the habit, then it can be treated with tongue crib and speech therapy.

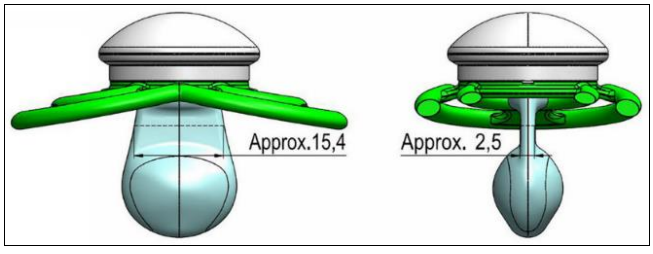

Fig 1: MAM Perfect Pacifier Courtesy: Nowak *et al*. Pacifier intervention in early malocclusion. Journal of Dentistry for Children-83:2, 2016

Nowak *et al* [3] did a study on a unique pacifier on anterior open bite and overjet in primary dentition. MAM Perfect (MAM USA, White Plains, N.Y., USA) is a pacifier developed in 2009. It has an extremely thin neck with a small cross-sectional area and a softer silicone material. The

thickness of the pacifier neck is 2.5 mm, whereas in other pacifiers the neck is four to five times thicker. The width of the neck is 15.4 mm, allowing sufficient area for the infant to grasp. It was seen that in children with existing increased open bite and overjet there was reductions in overjet and open bite after using the MAM Perfect pacifier for six months.

Management in Mixed dentition

Tongue cribs

1. Palatal cribs

These are used to prevent tongue from resting on the teeth. This can be fixed or removable. Fixed crib will serve the purpose of re-educating the tongue. They must be long enough to prevent the tongue from positioning itself below them. They induce a change in the resting position of the tongue, thus allowing tooth eruption and open bite closure. This change in tongue position alters sensory perception by the brain, thereby producing a new motor response. This response can be imprinted permanently in the brain, which explains the permanent change in tongue posture produced by spurs.

Fig 2: Palatal tongue crib

2. Mandibular cribs

Usually tongue cribs are placed in maxillary arch whereas it can also be placed in the mandibular arch, this depends on the position of the tongue. Meybodi [4] (2010) suggested the use of removable mandibular crib appliance. The effect of the palatal tongue crib is protrusion of the premaxilla thus increasing the overjet specially in early mixed dentition patients, this will be favourable for class III malocclusions and cleft lip and palate patients. In case of class II cases this would be unfavourable, overcoming of this situation can be done with mandibular crib. This is because the mandibular tongue crib forces the mandible into a forward position. Palatoglossus, Styloglossus, Chondroglossus and Hyoglossus muscles have a protrusive force that can be transferred via the tongue tips to the tongue cribs to the mandible thus improving the profile.

Elastic activator (Stellzing 1999) [5]

This is a modified activator with elastic posterior bite block for treating open bite cases. It should be worn for 14 hours per day. It incorporates upper and lower labial bow. The proclined maxillary incisors uprights with the activation of upper labial bow resulting in overjet correction.it is highly reliable as breakage is less. The rubber tubes used in this are changed every 2-3 months to maintain the tension in the neuromuscular system. If tongue thrusting is present tongue crib also can be incorporated.

Open bite bionator [6]

This appliance is a kind of bionator with posterior bite blocks to inhibit the extrusion of the posterior teeth. The acrylic portion extends from the lower lingual part into the upper region as a lingual shield. Labial bow in between the upper and lower incisors at the height of lip closure stimulates the lip to achieve a competent seal and relationship. Function of palatal bar is to move the tongue into a more posterior position. The acrylic bite blocks prevents eruption of the posterior teeth.

Weinbach and Smith [7] studied the effects of the open-bite bionator and reported good control of the vertical dimension with significant mandibular growth.

Frankel IV (FR IV) [8]

It is used to treat open bite and bimaxillary protrusion. It's usually used in mixed dentition. The FR IV appliance along with lip seal training, will alter the growth and development pattern of the mandible. It also changes the downward and backward growth direction of the mandible to an upward and forward direction, allowing the skeletal anterior open bite to be successfully corrected.

Twin block

The posterior bite block should extend up to the second molar so that the over eruption of second molars can be prevented. The occlusal contacts of the posteriors should be maintained. Trimming of the upper block should be avoided as it may cause lower molars to erupt and result in an open bite.

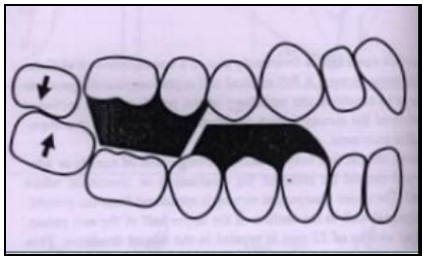

Fig 3: Overeruption of second molars

Orthopaedic appliances

- High pull headgear

Hyperdivergent open bite are usually treated with high pull headgear because it has been shown to effectively hold maxillary sutural growth and vertical dentoalveolar development. High-pull headgear produces intrusion and posterior displacement of maxillary molars with backward maxillary rotation.

Baumrind and co-workers [9] found that high-pull patients displayed relative increases in the Mandibular plane angle and reduced condylar growth.

- Headgear-Activator Teuscher Appliance (HATA)

Ullrich Teuscher [10] used the high pull headgear with the activator to counteract the undesired maxillary side effect. It's an activator with - 'torquing spurs on the upper incisors to prevent retroclination and headgear to produce more vertical control and anterior restraint on the maxilla. Teuscher was the first to combine the activator with high-pull headgear in the modified appliance for treatment of class II, division 1 malocclusion. The HATA treatment aims at correcting the malocclusion without diverting the anterior skeletal facial landmarks from their growth trajectories

- Vertical chin cup

The chin cup control downward maxillary displacement, inhibit anterior and posterior vertical maxillary growth, and growth of upper anterior face height but no changes in the amount of maxillary molar eruption.

- Extraction of first premolars and use a vertical pull-chin cup

The most important criteria for choosing a treatment method id stability.treatments with extractions (Janson *et al*. [11] and Vaden [12]) allow greater stability since retraction promotes bite closure thus decreasing the need for vertical elastics and the need to perform correction by extruding anterior teeth, Extractions also help in achieving lip seal as they cause retraction of the upper and lower incisors.On the contrary Goto *et al* [13] argued that treatments with extractions do not show stability since retraction of anterior teeth can encroach upon the tongue area.

Posterior Bite Block (PBB)

This is said to be effective by inhibiting the increase in height of the buccal dentoalveolar processes, thus preventing down and back rotation of the mandible.it helps in overbite correction and mandibular plane correction also 3 to 4mm PBB also decreased the palatal and mandibular planes divergence. PBB causes extrusion of incisors and intrusion of molars and also causes mandibular autorotation. According McNamara [14] maxillary complex was most affected by PBB; changes have been reported to occur throughout the craniofacial complex. It is most effective before cessation of growth of the jaws.

Rapid Molar Intruder [15] (RMI)

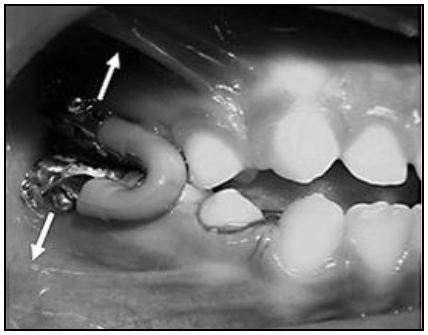

Fig 4: Rapid Molar Intruder Courtesy: Çinsar A, Alagha AR, Akyalçın S. Skeletal open bite correction with rapid molar intruder appliance in growing individuals. The Angle Orthodontist. 2007 Jul; 77(4):632-9.

This is the modification of the Jasper Jumper.it is a flexible fixed appliance that delivers light, continuous force. RMI is capable of moving single teeth or entire arch. RMI should be combined with upper Transpalatal arch and lower lingual arches as the intrusive forces on buccal side of molars which tips crowns buccally. It causes Molar intrusion and mandibular autorotation.

Spring loaded bite block [16]

Woodside and Linder-Aronson [17] first described the design of spring loaded bite block.in this device there was addition of springs to a posterior bite block. This restricts the extrusion of the maxillary permanent molars and vertical maxillary growth. Intrusion of the posterior teeth, autorotates mandible upward and forward. This corrects the anterior open bite and reduces the anterior facial height, also because of the oral gymnastic effect which increases the muscle strength and gives a stable result. This appliance should be used in patients before the pubertal growth spurt, since optimum improvement is often attainable only during this period.

Fig 5: Spring loaded biteblock Courtesy: Doshi UH, Bhad WA. Spring-loaded bite-blocks for early correction of skeletal open bite associated with thumb sucking. American journal of orthodontics and dentofacial orthopaedics. 2011 Jul

Magnetic Activator Device IV (MAD IV)

Ali Darendeliler [18] (1995) used this appliance to correct anterior open-bite. The MAD IV[14] has anterior attracting magnets as well as posterior repelling magnets. It consists of removable upper & lower acrylic plates, each containing 3 cylindrical Neodymium magnets coated with stainless steel. The attracting force of the anterior magnets is 300gm & the repelling force of the posterior magnets is also 300gm.

When the anterior segment of the maxilla is vertically correct or overdeveloped. Anterior and posterior magnets are kept in full contact.

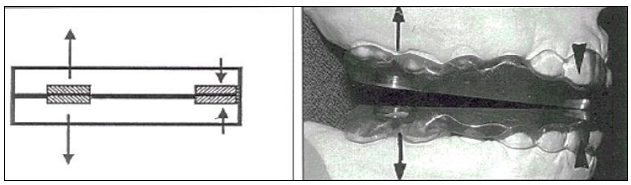

Fig 6: anterior and posterior magnets kept in full contact Courtesy: Darendeliler MA, Yüksel S, Meral O. Open-bite correction with the magnetic activator device IV. J Clin Orthod. 1995 Sep

When an additional extrusive effect is needed in the maxillary anterior region. The anterior magnets are positioned with a vertical opening of 2-3mm, while the posterior magnets are placed in full contact.

When only anterior extrusion is needed. The posterior magnets are omitted, and the anterior magnets are laced with an opening of 1-2mm, depending on the severity of the anterior open bite.

Active Vertical Corrector (ACV)

ACV [19] is a simple removable or fixed orthodontic appliance that intrudes the posterior teeth in both the maxilla and mandible by reciprocal forces. These are bite blocks with samarium cobalt magnets which are sealed in stainless steel capsule.it provides a simple reciprocal force system to rapidly intrude posterior teeth. This results in autorotation of the mandible and open bite correction. Study by Ingervall [20] showed that AVC produce quicker response in dental and skeletal vertical relationship in growing individuals. I.e. an average of 3mm of anterior open bite closure over a 8

months treatment period.

Management in Permanent dentition
Bjork (1969) and Skieller *et al* (1984) observed that the posterior teeth in open-bite malocclusion are usually mesially tipped. The attachments should be placed with a mesial angulation on these teeth which will help in correcting the angulations and close the open bite with vertical elastics in the anterior teeth to close the open bite. Action of the vertical elastics are transmitted to the posterior teeth by the archwire, and this will upright them.

Extrusion arch [21]
Wire used is 16 x 22 SS or 17 X25 TMA with 90˚ offset bend at the molars.

At The Molar
A second order couple is generated at the molar with crown tipping mesially and root tipping distally. The equilibrium is achieved because the anterior end of the wire extrudes the incisors and posterior end intrudes the molars. Relatively very minimal buccal flaring of the molar is seen.

At The Incisors
Extrusion can involve single teeth or group of teeth. When a group of teeth are to be extruded, a segment of heavy arch wire may be used in the brackets of the anterior teeth, and the teeth are extruded as if they were one big tooth.
Whether the extrusion arch is tied segmentally or to continuous arch wire or placed directly into the brackets the effect is the same.

Elastics
- **Triangular elastics**

It aids in the improvement of class I cuspid intercuspation and increasing the overbite relationship anteriorly by closing open bites in the range of 0.5 to 1.5 mm. They extend from the upper cuspid to the lower cuspid and first bicuspid teeth.

- **Vertical elastics**

Vertical elastics should be used in the anterior teeth to close the open bite. Action of the vertical elastics are transmitted to the posterior teeth by the archwire, and this will upright them, contributing in closing the open bite, due to intrusion of the distal of these teeth.

- **Box elastics**

Box elastics have a box shape configuration. They may extend from the lower lateral incisors, to the upper laterals (or) central incisor teeth or from the lower cuspids to the upper laterals.

- **M or W elastics**

In an open bite case, some amount curve of spee should have been placed in the lower arch. Therefore, some curve should be placed in the upper arch as well. The arch wire is sectioned distal to laterals or cuspids and up and down elastics ("M" with a tail) are worn. The elastic begins at the lower cuspid, continues to the maxillary cuspid and finishes at the maxillary molar.

Multiloop Edgewise Arch Wire (MEAW) [22]
It was introduced by Kim. The MEAW contains horizontal and vertical loops fabricated from a 16 x 22 SS wire in an L - shape fashion on a 0.018 slot. The vertical loop component serves as a break between the teeth, gives flexibility to the arch wire, and allows horizontal control of the tooth positions. Levelling and aligning should be completed and all the bracket positions should be corrected before starting with MEAW, also there is constant use of vertical elastics in anterior teeth with 3-5˚ tip back activations from first premolars to second molar.

Temporary anchorage devices (TAD's)

Fig 7: Intrusion of posterior using implants

Mini implants provide adequate anchorage for maxillary molar intrusion. By using micro-implant with bite block [23], we can intrude posterior teeth, allowing the mandible to auto-rotate counter clockwise direction, thus closing the open bite. TAD based intrusion in considerably stable. With the use of TAD's, the orthognathic surgeries can be avoided in certain open bite cases [24].

Skeletal anchorage system

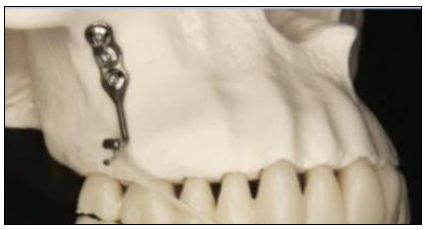

Fig 8: Skeletal anchorage with miniplates

The skeletal anchorage system was developed by Umemori and Sugawara [25]. It consists of titanium miniplates, which are stabilized in the maxilla or mandible using screws. Titanium miniplates are placed in the buccal cortical bone in the apical regions of the first and second molars produce as much as 3 to 5 mm of molar intrusion and counter clockwise rotation of the occlusal plane.

Surgical management [26]
Skeletal open bite is ideally treated with a combination of orthodontics and orthognathic surgery.
According to Arnett and McLaughlin (2004) the following are the stages for combined orthodontic and surgical treatment
- Treatment planning
- Orthodontic treatment
- Presurgical impression and revaluation of teeth positioning
- Presurgical records and definite treatment planning
- Plaster model surgery and construction of an intermediary splint
- Orthognathic surgery

- Bracket rebonding, finishing procedures and appliance removal
- Retention and final records.

Class I open bite
Orthodontic
Cases in which anterior and posteriors segments are in two different level they should not be leveled and aligned with continues archwire to avoid extrusion of anterior teeth.
The decision of Non extraction or extraction depends on the amount of crowding and anteroposterior position of mandibular incisors.

Surgical
Superiorly reposition the maxilla. When two planes are present segmental orthodontic correction with segmental surgical correction is indicated.
When there is dual occlusal plane and transverse maxillary deficiency, Lefort I with three piece osteotomy should be performed.
The mandible will autorate superiorly and anteriorly. Genioplasty can be done if needed after the autorotation of the mandible.
So the surgical solutions for class I open bite are:
- Maxillary superior repositioning with or without genioplasty
- Maxillary superior repositioning with mandibular setback with without genioplasty
- Maxillary superior repositioning with mandibular advancement with or without genioplasty
- Differential superior repositioning of the anterior and posterior segments and simultaneous expansion of buccal segments.

Fig 9: Three piece Lefort I osteotomy

Class II open bite
Orthodontic
One piece Lefort I osteotomy: level, align and coordinate the maxillary arch and align the mandibular arch. Expand buccal segments of teeth only where the teeth are palatally inclined in relation to basal bone.

Segmental Le fort I osteotomy: Level, align maxillary arch in segments Deviate the roots in the intended interdental osteotomy areas. Level and align the mandibular arch.

Surgical
- Superior repositiong of the maxilla- total or segmental- open bite can be corrected by more superior repositiong of the posterior segment than the anterior segment
- Surgical expansion of buccal segments by segmental surgery
- Autorotation of the mandible
- If required surgical advancement of the mandible and Advancement genioplasty [27].

Class III open bite
Orthodontic
Any existing dental compensation should be removed. When segmental surgery is required align the arch in segments and deviate the roots where the osteotomy cuts are to be given. Level and align mandibular arch.

Surgical
- One piece Le fort I osteotomy with superior repositioning of the maxilla
- Segmental surgery with differential repositioning of the maxilla
- Expansion of buccal segments
- If required Mandibular setbacks and Genioplasty

Posterior Open Bite
Posterior open bite is a condition characterized by lack of contact between the posteriors when the teeth are in centric occlusion. It mostly occurs in a segment of the posterior teeth.
Two possible causes of posterior open bite are
- mechanical interference with eruption, either before or after the tooth emerges from the alveolar bone

Fig 10: Posterior open bite correction with implants Courtesy: Alyami B. Diagnosis and Management of a Unilateral Posterior Open Bite Using a Temporary Anchorage Device (TAD): Case Report and Review of the Literature. Case reports in dentistry. 2020 Feb 1; 2020.

- Failure of the eruptive mechanism of the tooth so that the expected amount of eruption does not occur.

Management of posterior open bite
1. Primary aim is to eliminate the cause
2. Lateral tongue spikes for lateral tongue thrust
3. Posterior open bite correction with implants [28]
4. Open bite due to infraocclusion of ankylosed teeth, it is best treated by crowns on posteriors to restore normal occlusal level.

Retention
According to Shapiro (2002) [29] the main etiological factors responsible for relapse after orthodontic correction are
- Latent vertical growth of the face and the role of the tongue.
- Mandibular musculature and incompletely understood Biomechanical factors influencing the Elevator group & Suprahyoid group of muscles.

According to profit retention is done by
- controlling the habit
- high pull headgear in conjunction with removable

appliance
- open bite activator or bionator
- posterior bite block
- Retainer in day time and open bite bionator in night time.

The protocols for retention after anterior open bite treatment are similar to those for other malocclusions. Conventional removable retainers or retainers with tongue grids are used.
Other retainers:
- Hawleys retainers with tongue crib
- Tooth positioners
- spur-implanted Essix Retainers (Uzdil F *et al* 2010) [30]
- Skeletal retention using miniscrews and vertical elastic is an effective method for retention of anterior open bite cases (Albaker B 2013) [31]

Conclusion

The treatment of open bite remains a challenge to the clinician, and careful diagnosis and timely intervention will improve the success of treating this malocclusion. The recent trend of combining orthodontic and surgical methods to manage open bite, which is a multifactorial problem has been successful. So putting meticulous attention to biomechanics, successful treatment of very difficult open bite cases could be achieved.

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