Literature Review

ANTERIOR OPEN-BITE: A REVIEW

O.D. Otuyemi, BDS, MPH, MSc, D Orth RCS*; J.H. Noar, BDS, FDS, MSc, D Orth RCS**

لم تحظى مشكلة العضة الأمامية المفتوحة بالإهتمام الذي تستحقه في الأدب الطبي على قدر أهميتها التجميلية والوظيفية بالرغم من إختلاف إنتشار العضة الأمامية المفتوحة لدى شعوب العالم إلا أنها تعتبر مشكلة تواجه أخصائي تقويم الأسنان وتولد لديهم إهتمام بها .

هذه المقالة تراجع ما تم نشره عن هذه المشكلة في مقالات عديدة وخاصة فيما يتعلق بدرجة انتشارها والأسباب المؤدية لها .

بالإضافة إلى استعراض الطرق المختلفة لتشخيص وعلاج هذه المشكلة .

Anterior open-bite has received relatively scanty attention in the literature despite its obvious aesthetic and functional implications. In spite of its worldwide variation, it is a relatively common malocclusion trait. Difficulty in predicting its long-term stability continues to generate interest among orthodontists. This article reviews the relevant literature on the subject particularly its prevalence, common aeteiological factors and their possible contribution to the development of anterior open-bites. Clinical and cephalometric characteristics in the differential diagnosis were also discussed. Treatment of anterior open-bites including magnets and surgery were highlighted.

Introduction

Anterior open-bite is said to exist when there is no incisor contact and vertical overlap of lower incisors by the uppers. Incomplete overbite is a minor variant of anterior open-bite and is present where there is no lower incisor contact with either upper incisor or palate but the incisal overlap still exists. The severity of anterior open-bite may vary from almost edge to edge relationship to a severe handicapping open-bite [Figs. 1,2]. Mizrahi[1] described anterior open-bite as a vertical discrepancy where upper incisor crowns fail to overlap the incisal third of the lower incisor crowns when the mandible is brought into full occlusion.

Despite the obvious functional and aesthetic problems produced, the subject has received relatively minor attention in the dental literature. The long-term stability of anterior open-bite correction is difficult to predict as it continues to generate considerable interest among orthodontists.[2-16] Also of interest is the variation of anterior open- bite among the world's population (Table 1). There seems to be a general tendency towards racial predilection.

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* Consultant Orthodontist and Senior Lecturer, College of Health Sciences, Faculty of Dentistry, Obafemi Owalowo University, Ife-Ife, Nigeria

**Consultant Orthodontist and Senior Lecturer, Eastman Eastman Dental Hospital, London, UK.

Address reprint requests to: Dr. O.D. Otuyemi

Figure 1. Dental open bite caused by digit sucking.

Figure 2. Open bite associated with development alteration of the skeletal configuration..

Isolated posterior or lateral open-bites are rare and there is seldom any obvious cause. These are, however, attributed to primary failure of alveolar process development.[17,18] Brady[19] and Ireland[20] reported cases of familial posterior open-bites in a mother and son, and two sisters, respectively. Bosker et al[21] earlier suggested this condition to be transmitted by an autosomal dominant gene. Mew[22], however, suggested that the phenomena may be related to tongue between tooth postures.

Table 1. Prevalence of anterior open bite in various populations.

Authors	Country	Prevalence (%)
Haynes[2] Todd[3] Roberts and Goose[4]	Britain	0.4-3.0
Maliu et al[5]	Kenya	11.4
Gardiner[6]	Libya	1.0
Isiekwe[7] Otuyemi and Abidoye*	Nigeria	7.0 -10.2
Al-Emran et al[9]	Saudi Arabia	3.0-3.6
Diagne et al[10]	Senegal	4.9
Abu-Affan et al[11]	Sudan	1.1
Keruosuo et al[12] Mugonzibwa[13]	Tanzania	8.0
Kelly et al[14] Kelly and Harvey[15]	USA	1 Caucasians 10 African-Americans
Noar and Portnoy[16]	Zambia	5.0

This paper intends to review the literature on anterior open-bite including its etiology, clinical features and management.

Etiology and Clinical Features

The cause of anterior open-bite is generally multi-factorial and can be attributed to a number of facts. Clinically, anterior open-bite is grouped into two main categories: the dental or acquired open-bites, which do not show any distinguishing craniofacial malformations; and the skeletal open-bite with superimposed craniofacial dysplasia. Both the dental and skeletal open-bites may be classified as simple and complex, respectively, based on the difficulty in their diagnoses and management.[23] From the etiological standpoint, anterior open-bites fall into six groups with specific causes.

/. Dental open-bite (Habits)

This open-bite is caused by obstruction of eruption of the anterior teeth. Classically, this open-bite is asymmetrical and fits snugly around the offending agent. Many of these cases show spontaneous remissions[24], and about 75 to 80% had marked improvement without any form of treatment.[25] Since the vast major-

ity of these patients are children in the transitional dental stage, it is conceivable that the rate of eruption of the anterior teeth will slow down temporarily. These subjects are often referred to as having "transitional or pseudo open-bite".

2. *Skeletal open-bite (Hereditary)*

This group shows some craniofacial malformation which often varies with maturity.[26] Adverse functional activities such as mouth breathing may affect the facial architecture and enhance the development of open-bite.[27,28] Masticatory muscle functions probably affect mandibular posture and progressively alter the skeletal configuration.[29,30]

3. *Abnormal tongue function*

The cause and effect relationship of abnormal tongue function and open-bite is not clear.[1] This controversy still rages on because little scientific evidence exists to establish the relationship. However, Cooke[31] reported that young patients possessing anterior open-bite are frequently presented with large tongues. Evidence also suggests that in some cases, the aberrant tongue[32] and tongue behavior known as "endogenous tongue thrust"[33] are the actual cause of the anterior open-bite. The population of children with such endogenous tongue thrust behavior is small (0.6%) and they often demonstrate lisping with open-bite larger than would be expected with a tongue to lower anterior oral seal and also with excessive muscular activity around the lips during swallowing.[32]

4. *Neurological disturbances*

Neurological disorders contribute to the development of anterior open-bite. Gershater[34] demonstrated a very high incidence (32.3%) of anterior open-bite in his survey of mentally retarded and emotionally disturbed children. This supports other studies where problems in controlling the tongue at rest or in function are encountered.

5. *Iatrogenic open-bite*

This open-bite is produced by active orthodontic treatment obviously represent examples of poor treatment technique or inappropriate treatment planning. More common mistakes in this category include the use of anterior bite plane in already reduced overbite and the extrusion of upper molars in high angle cases.

6. *Pathological open-bite*

Pathological conditions may also present as anterior open-bite, such as in cleft palate, acromegaly or in bilateral condylar fracture cases. Le Fort II and III fracture cases often present with gagging occlusion, hence anterior open-bite.[35,36]

Cephalometric studies on anterior open bite

A review of the literature indicates that there are no consensus on the cephalometric criteria for determining the presence of open-bites. Dung and Smith[37] reported that the cephalometric criteria used in their study were not predictive of open-bite tendency.

While the dental or acquired open-bites do not show any distinguishing cephalometric features from the normal dentofacial characteristics, skeletal open-bites, however, show a number of cephalometric characteristics. This include increased lower anterior facial height and comparatively short posterior facial height.[38,42] Others are steep mandibular plane,[38,40,41,43] large gonial angle,[38,41] as well as increased maxillary posterior dentoalveolar height.[38,41] However, Nahoun et al[44] showed that the dento alveolar height is normal except for the mandibular molar which is significantly reduced. Sassouni and Nanda[38] and Nahoun[45] reported that the angle between the sellanasion plane and the palatal plane was significantly reduced in their sample while Frost and associates,[40] Subtenly and Sakuda[41], Enunlu[42] and Lowe[45] showed no significant difference in this angle, which suggested that open-bite deformity arises

inferior to the palatal plane. Another area of agreement among the many investigators who studied skeletal open-bite is the statistically significant increase in the angle between the sella-nasion plane and the occlusal plane.[38404146]

Most cephalometric studies comparing control samples to subjects with skeletal open-bite exhibited no significant difference in the anterior cranial base as measured from sella to nasion[40,41,44] in the cranial base angle (N-S-Ba) or in the angle between the Frankfort horizontal plane and the S-N plane[38,40]. However, Subtenly and Sakuda[41] did report that the distance between sella and basion was less in their open-bite sample, indicating a shortened posterior cranial base. These findings seem to indicate that the cranial base is not greatly affected in skeletal open-bite cases.

Diagnosis and Treatment

Clinical assessment should include accurate medical and dental history in addition to cephalometric and study model analyses if one is to differentiate between various types of anterior open-bite. Treatment planning must be based on the assessment and evaluation of every individual case which may be unique. Some cases may undergo spontaneous improvement without any treatment.

A variety of treatment philosophies and appliance techniques have been used in the correction of anterior open-bite. These can be categorized into simple treatment which are within the scope of a dental practitioner's clinical responsibility while complex treatment may, however, be beyond this scope and such a case would benefit from a specialist advice.

Simple orthodontic treatment

The treatment of non-skeletal open-bite in which the child indulges in some form of non-nutritive sucking should include adequate effort to dissuade him from this habit, although most clinicians tend to agree that intervention is not usually indicated until about the age of 5 years when the permanent dentition starts to erupt. Prof fit and Fields[47] suggested a system whereby a small tangible reward is provided daily for not engaging in the habit. Other method of interrupting such a habit, especially during sleep and other recreation, is by placing a cotton glove on the hand or a band-aid on the thumb or finger. Fixed habit breaking devices for control of digit sucking and anterior tongue thrusting are also used by a number of general dental practitioners and pedodontists. One of such appliances is the use of quadhelix (0.038") which facilitates expansion of the constricted maxillary arch as well as discourages the habit. Quadhelix appliance often causes buccal tipping and extrusion of lingual cusps of molars resulting in further increase of open-bite in the anterior region. This side effect is minimized by actively tipping the bands on the appliance lingually to counteract this undesirable effect. Removable appliances could be useful but are not usually recommended because of its non-compliance.[47] Force should not be used to break the habit because of psychologic problems.[48] The use of dummy sucking, which is more socially acceptable, has proved to be a better alternative. Larsson[49] demonstrated that children who sucked dummies stopped using them by the age of six years and showed no tendency to suck digits, whereas the group that sucked digits continued with the habit in significant number according to age-groups that are socially unacceptable and orthodontically harmful.

Complex orthodontic treatment

Removable maxillary intrusion splints which carry posterior bite blocks are very useful in closing anterior open-bite. Functional appliance with bite blocks, such as Clark's twin block (CTB) and Bionator, have also proved valuable in the vertical control of molars.[50] Both techniques carry extraoral tube for the use of headgear. The effects of the passive acrylic posterior bite blocks on the skeletal and dento-alveolar structures in comparison with the control subjects have been studied in previous

human clinical studies.[47,51] Recently, Iscan et al[52] described the use of spring-loaded posterior bite-block in the correction of anterior open-bite. This appliance comprises upper and lower posterior bite blocks held together by helical springs which acts by intruding the buccal segments with consequently forward and upward mandibular autorotations. These methods are quite effective in growing individuals. The use of other functional appliances, like Frankel IV, open-bite bionators, kinators, in the correction of anterior open-bites have also been mentioned by some authors.[47,53,54]

The principle of the anterior open-bite orthodontic treatment includes vertical control of molars and incisors and tipping movement of the incisors. High pull headgear is quite useful in vertical control of the molars. Careful use of Class II intermaxillary elastics should be employed in open-bite tendencies. A millimeter of molar extrusion will open the bite even when accompanied by a millimeter of incisor extrusion in Class II elastics since the molar is closer to the condylar hinge axis. A multiloop Edgewise archwire technique has been used to extrude the anterior teeth while exerting distal uprighting forces on the posterior teeth.[55] This technique has previously been described and was based on the characteristic features of anterior open-bite.[56] Treatment plan should also include the extraction of terminal molars and distal tipping of the dentition. Information has not been available on the stability of this method. Full-time use of vertical box elastics is recommended. More recently, the use of reverse curve nickel-titanium archwire, instead of multiloop wires, had worked well.[57] The use of transpalatal bar, 0.04" thick or half round wire (5-6 mm) kept away from the soft tissues of the palate, allows the tongue to exert a depressive action on the molars, reducing anterior open-bite.

Recently, removable and fixed appliances with acrylic bite blocks incorporating magnets to intrude the molars have been used to correct anterior open-bite [Figs. 3a-d]. Dellinger reported that the rate of tooth movement with removable bite block system containing repelling Samarium cobalt magnets (active vertical corrector) was greater than conventional approach. Kuster and Ingervall[59] reported the advantages of fixed magnetic bite blocks. However, Woods and Nanda,[60,61] in their studies on the growing and non-growing primates saw little difference between the results of these "active" and "passive" bite block appliances without magnets and questioned whether the intrusion effects are due to the magnets incorporated in the appliance systems or is it due solely to the increased vertical dimension caused by the acrylic blocks. In a related study, Noar et al[62] found no sufficient evidence from a laboratory study to support the fact that magnets in bite blocks significantly improve its performance in buccal intrusion. Recent study[63] has shown that the thickness and orientation of magnets on the bite blocks may have serious implication on the force produced between them.

Orthognathic surgery continues to play an important role in the treatment of anterior open bite. In cases where anterior facial height is to be reduced surgically (skeletal open-bite), most of the orthodontic tooth movement is accomplished prior to surgery. Maximizing the presurgical orthodontics lead to minimal postsurgical mechanics. Avoidance of intrusive mechanics in the buccal region, e.g. high pull headgear, and concurrent avoidance of any extrusive mechanics in the anterior region will also facilitate maximum surgical correction and reduced relapse of the open-bite.[64] This is usually followed by one-piece Le Fort I osteotomy with more impaction of posterior maxillary segment. An alternative surgical approach is presurgical segmental leveling in the upper arch followed by Le Fort I osteotomy with a three-part maxillary surgery. Autorotation of the mandible helps close down the open-bite. In some cases, bimaxillary procedure may be necessary. Segmen-

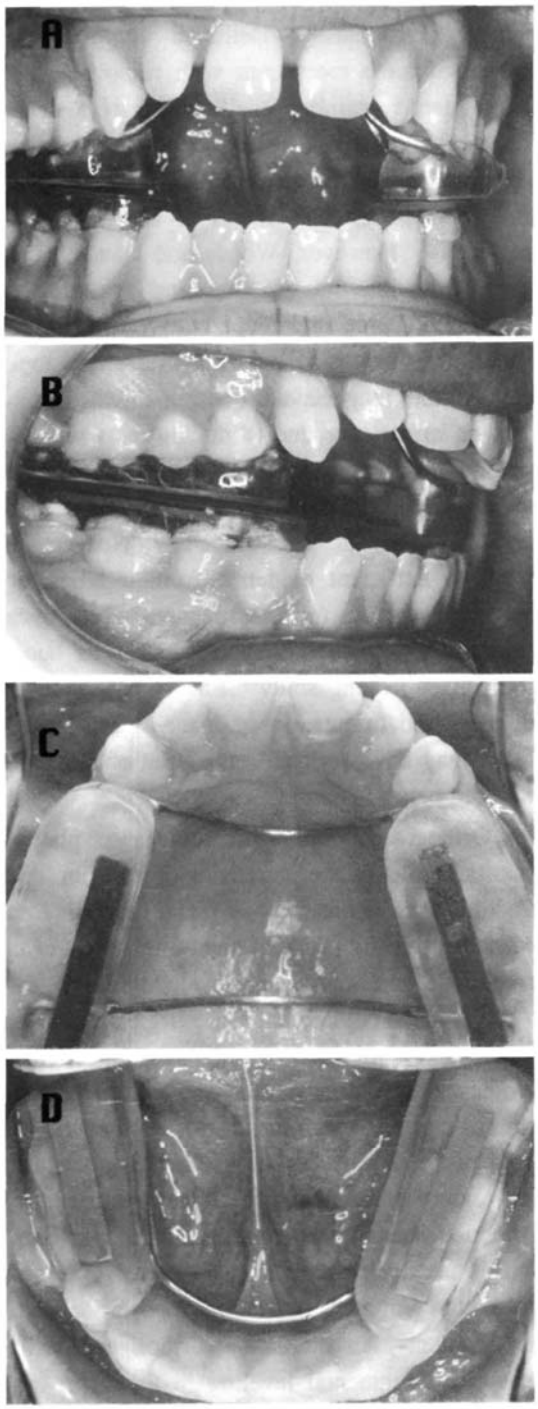

Figure 3a-d. Acrylic blocks incorporating Samarium cobalt magnets to intrude buccal segments to correct anterior open bite: (a) anterior view; (b) lateral view; (c) upper occlusal view and (d) lower occlusal view.

tal surgeries, such as Schuchardt procedure with impaction of buccal segments and Kole mandibular procedure, often show disappointed results with frequent tendency towards relapse.[53] Bell and Dann,[65] however, reported a measure of stability in the correction of open-bite using anterior segmental surgical procedures. This stability is probably directly related to the non-involvement of the muscles of mastication in the biomechanics of the surgical change. Anterior segmental osteotomies have limited use in gross skeletal open-bite cases and/or cases of gross antero-posterior malrelationship. In addition to the various surgical procedures described in the literature, many clinicians have also advocated a partial glossectomy[66] in the management of open-bite cases. However, in recent times, partial glossectomy appears to have fallen out of favor in the management of such cases,[67] possibly because of many reports on disturbance to sensation, speech difficulties and the doubtful efficacy of glossectomy in improving the progress or preventing the relapse of the open-bite correction.[68]

Retention and Prognosis

Many studies have indicated that if open-bite correction is not stable, it was because the tongue continues to be postured anteriorly which causes the bite to reopen.[69-72] Incomplete cessation of digit sucking habits, following treatment, often results in the relapse of anterior open-bite due to continued excessive vertical growth and eruption of posterior teeth.[47] Controlling the eruption of upper molar until late adolescence is the key to retention in anterior open-bite cases.[47] High pull headgear to upper molars in addition to conventional removable retainers prevent relapse of open-bite. Removable appliances with bite blocks, such as open-bite activator worn at night in addition to daytime wear of removable appliance retainer over a long retention period, has also proved valuable in the prevention of relapse of anterior open-bite.[47] Long-term prognosis of anterior open-bite is somewhat unpre-

dictable. Lopez-Gavito et al assessed 41 patients all of whom had had an anterior open-bite of at least 3mm. Ten years after treatment, only 35% of patients had an overbite of at least 3mm. No reliable predictor of post-treatment relapse was found.

Conclusions

There is a general variation in anterior open-bite among the world's population with great tendency towards racial predilection. Basically, two main clinical groups exist. Acquired or dental groups are generally the result of a specific insult or trauma. Developmental or skeletal open-bites are usually much more complex in nature. A detailed understanding of its etiology and developmental processes is, thus, essential for their management. The relapse of anterior open-bite could be minimized with appropriate retention regimen. On a long-term basis, no reliable predictors of post-treatment relapse could yet be found.

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