ANTERIOR OPEN-BITE

DIAGNOSIS

AND

TREATMENT

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1990

Treatise presented in partial fulfilment of the requirements for the Degree of Master of Dental Surgery.
Acknowledgements

A very special thanks to Professor Keith Godfrey for his help and patience over the years.

"It is a shameful thing to be weary of inquiry, when what we search for is excellence".  
- Cicero

I gratefully acknowledge the suggestions of Fransiscus Tan in the preparation of this treatise.

Thank you to Dr. Charles Savage, the Superintendent of the United Dental Hospital for allowing me to use the facilities of the hospital, and

Thanks to the staff and postgraduate students on the 8th floor of the UDH, for you help.
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Introduction

According to Subtelny et.al. (1964), open-bite must be considered as a deviation in the vertical relationship of the maxillary and mandibular dental arches. In an open-bite there should be a definite lack of contact, in the vertical direction, between opposing segments of teeth. The degree of openness can vary from patient to patient, but an edge-to-edge relationship, or some degree of over-bite, cannot rightfully be categorized as an open-bite.

The anterior open-bite topic was of particular interest to me as I work in the School Dental Service. This entails analysis of the occlusions of the many children who are being treated by Dental Therapists in the clinics. The anterior open-bite malocclusion, appears quite often among children and I felt a need for additional knowledge to be able to differentiate between the more simple dental open-bite and the more severe skeletal cases.

It is a disfiguring condition, and invariably parents are anxious for reassurance about the possible causes and prognosis of the problem. A treatise on open-bite has meant that I have had to read widely on the subject and this has given me a far greater knowledge and understanding, when children now present with this problem.
CHAPTER I

ANTERIOR OPEN-BITE

GENERAL OVERVIEW
Figure 1 Class II division I malocclusion associated with an anterior open bite. Because of the anteroposterior discrepancy, the mandibular anteriors would supræerupt into the palate if it were not for the tongue-thrusting.

Descriptions of open-bite differ among various authors. Some orthodontists consider an open-bite to be present when there is less than an average overbite; others consider an edge-to-edge relationship to be an open-bite, while others specify that a definite degree of openness must be present.

According to Subtelny and Sakuda (1964) (1), an anterior open-bite is present when "On a cephalogram, taken with the teeth in occlusion, there is a definite separation between the upper and lower incisal edges when measured relative to the occlusal plane or at a perpendicular to the palatal plane".

Moyers (1975) (2), has two definitions of open-bite. The first defines it as the absence of incisal overlap, and the second indicates that there is the absence of an occlusal stop or contact. True open-bite can occur with Cl.I, Cl.II div 1 and Cl. III malocclusions. (Figure 2)

It is most important to consider the lack of an occlusal contact or stop in centric relation, since some cases e.g. Cl II div 1 may show initial incisal overlap and what seems to be an unimportant lack of intermaxillary incisal contact (2), i.e. incomplete overbite.
Figure 2A The definition of open bite. Left, normal incisal relationship. Center, an open bite without vertical overlap of the incisors. Right, an open bite with vertical overlap of the incisors. This latter type of open bite is often not diagnosed.


Figure 2B Mild open bites, often undiagnosed at the start of treatment, are dramatized during treatment if the incisors are retracted into the functional space of the tongue.

During treatment, the occlusal plane is levelled and incisors are retracted. The open-bite then becomes more obvious. This is due to the fact that most orthodontic mechanotherapy extrudes teeth somewhat, and in open-bite tendency cases treatment is particularly likely to result in clockwise mandibular rotation. (3).

Perusing the literature (4) (5), it becomes apparent that there are many more open-bites at an early age than can be observed at the adolescent stage of development. This observation poses some interesting questions. Does growth play an important role in open-bite? Or are there other factors which are influential in the formation of an open-bite at the early stages of development?

Open-bites can be divided into two general categories.

1. dentoalveolar open-bite.

2. skeletal open-bite, in which there is a discrepancy in the cranial bases, mandible and/or maxilla.

Nahoum, Horowitz and Benedicto, (1972) (6) found the posterior facial height to be shorter in open-bite subjects. Frost (1980) (7), found that the deformity existed below the palatal plane and involved the mandibular plane angle secondary to maxillary
dento/alveolar vertical excess, resulting in anterior open-bite.

According to Proffit (1968) (8), "The relationship of the muscular function to the development of malocclusion remains unclear. Anterior open-bite has been prominently associated with abnormal tongue habits. Tongue position, in turn, is related to the posture of the entire head and neck, and all these may unfortunately be influenced by the necessity to maintain the pharyngeal airway".

According to Moyers (1975) (2), the causes of open-bite may generally be grouped into:

1. vertical growth deficiencies, or the disturbances in the eruption of teeth and alveolar growth e.g. ankylosed teeth.

2. disproportionate soft-tissue growth, abnormal muscle function with mechanical interference of eruption, and alveolar growth.

(Figure 3)

Four primary factors in the dental equilibrium can be identified, Proffit (1978) (9):

1. intrinsic forces by tongue and lips.

2. extrinsic forces - habits (thumb-sucking, orthodontic appliances),

3. forces from dental occlusion, and,

4. forces from the periodontal membrane (eruptive forces).
Thus it can be seen that an anterior open-bite malocclusion is not a simple problem. It is a complex morphologic and functional anomaly, that cannot be considered a single entity for which some simple genetic mechanism is responsible (Horowitz and Hixon 1966) (10). It is multifactorial in aetiology. Anterior open-bites, can be socially and psychologically a problem for some patients.

According to Reaney (1977) (1), and Bloomer (1963) (12), people with open-bites have problems with making certain sounds for speech, for example, if the upper teeth cannot touch the lower lip, the patient has difficulties with the /f, and v/ sounds. If the lips cannot be brought into contact, the /p, b, and m/ sounds are impossible to pronounce.

"The psychosocial aspects of overcoming the unattractiveness of the physiognomic features of severe open-bites should not be underestimated". Frankel and Frankel (1983) (13).

The best approach to a complex problem is a multi-disciplinary one, with the co-operation of dentist, orthodontist, speech pathologist, E.N.T. surgeon and oral surgeon.

The proper diagnosis of the problem requires that one has all the relevant data, using such aides as, study models, cephalograms, and photographs.
Only then, with all the data collected, and the help of other professionals, is one able to correctly diagnose and treat with a modicum of expertise the very complex problem of anterior open-bite.
CHAPTER II

AETIOLOGY
Anterior open-bite like any other malocclusion is the result of certain causes either of hereditary or non-hereditary origin, that act pre- or post-natally on the tissues of the orofacial region.

Hereditary factors

The open-bite anomaly is most often associated with inherited facial growth. In the same way that horizontal skeletal dysplasias appear to be inherited, so dysplasias in the vertical plane may also be inherited. (6)

Three major theories (1) in recent years have attempted to explain the determinants of craniofacial growth.

1. bone, like other tissues, is the primary determinant of its own growth. (2)

2. cartilage is the primary (3) determinant of skeletal growth, while bone responds secondarily and passively; and

3. the soft tissue matrix (4) in which the skeletal elements are embedded is the primary determinant of growth, and both bone and cartilage are secondary followers.

The major difference in the theories is the location at which genetic control is expressed. The first theory (2) implies that genetic control is expressed directly at the level of the bone, and therefore its locus should be the peristeum. The second or cartilage theory (3) suggests that genetic
control is expressed in the cartilage, while bone responds passively to being displaced. This indirect genetic control is called epigenetic. The third theory (4) assumes that genetic control is mediated to a large extent outside the skeletal system and that growth of both bone and cartilage is controlled epigenetically, occurring only in response to a signal from other tissues.

It is apparent that the more indirectly growth is controlled, the greater the opportunity for environmental influences to affect it and vice versa. Thus, if the third theory were correct, considerably greater environmental influence could be expected, than under the first theory. In contemporary thought, the "truth" may be found in some synthesis of the second and third theories, while the first, though it was the dominant view as recently as the 1950's, has largely been discarded. (1)

Definition of Epigenetic

Moss, (1985) (5) "Epigenetic in a general way, may be used to describe the sum of all the biomechanical, bioelectrical, biochemical and biophysical parameters - instantaneously present, intra, inter, and extracellularly - all of which are produced by the functioning of the cell, tissue, organ or organism itself". It should be noted that these
same epigenetic factors serve as an internal environment and must be considered in addition to classical external environmental genetics. It is postulated that epigenetic factors act upon the products of the genome to regulate all developmental processes leading to the production, increase, and maintenance of biological structural complexity. It has been shown, also, that these epigenetic factors serve to produce "feed back" regulations of the genome itself.

Non-hereditary factors

Subtelny and Sakuda (1964) (7) and Tulley (1969) (8), have stressed the abnormal function patterns of the tongue, pernicious oral habits (Figure 3), abnormal swallowing patterns (Figure 4) and speech problems, all contributing to, and being part of, the open-bite phenomenon. A malfunction of the tongue can be a contributing cause or the result of an abnormal swallowing behaviour.

According to Gershater (1972) (9), the site of the open-bite deformity depends on which forces predominate, and the ability of the teeth and supporting structures to resist change. If, for example, there is an abnormal swallowing pattern and the strong propelling forces of the tongue are directed forward, the chances are that there would be
Figure 3  Adaptation of oral and facial musculature to thumb sucking. Note malposition of tongue, mandible, and circumoral muscles.

Figure 4  Tracings of selected cineradiographic frames obtained during the act of swallowing on a patient with an open bite malocclusion.

a tendency toward an anterior open-bite. Also the presence of pernicious thumb or finger sucking, lip and mouth breathing habits, and poor labial musculature, would greatly influence the severity of the anterior open-bite.

On the other hand, in the absence of pernicious oral habits, and if the forward propelling forces are counteracted by a strong oral labial musculature and the maxillary incisors and supporting structures resist change, then the chances of causing an anterior open-bite are greatly reduced.

As a result, the abnormal tongue forces are diverted elsewhere, a circumstance which may result in a lateral open-bite, or an incisal edge-to-edge relationship. (9)

Ballard (1955), stated that the basis of any analysis and behaviour is the concept that each individual has an innately determined posture, and innate basic patterns of motor behaviour with superimposed, reflexly produced, and maintained habit postures, and habit patterns of activity. As far as the tongue is concerned, as seen from lateral skull radiographs, there is a distinct tendency for the tongue posture to vary as the maxillary-mandibular plane angle varies. The higher the angle, the lower
the dorsum of the tongue in relation to hard and soft palates.

As far as the occlusion is concerned, the lower the tongue posture in relation to the maxillary arch, the greater is the possibility of a lateral contraction of the maxillary arch producing, in the extreme degree a bilateral lingual occlusion of the maxillary buccal segment. It has been found from clinical experience, that any attempt to treat this bilateral lingual occlusion by lateral expansion is doomed to failure because the tongue will not behave in the usual way within the maxillary arch to maintain the expansion. (21)

Sucking Habits

Factors that must be recognised and evaluated before the question of degree of damage to the teeth and investing tissues due to the sucking habits are:

- duration
- frequency
- intensity, and
- location

Thumb or finger sucking in a child up to the age of four or five years, is considered to be a normal experience resulting in no permanent form of malocclusion. However, persistent thumb sucking extending into the mixed and permanent dentition age groups may well result in anterior open-bite (Popovich and Thompson, 1973) (10)
Certain children actively suck their thumb or finger; others just allow the thumb to rest passively in the mouth. Variations in the intensity and the continuity of the habit will result in malocclusions of varying severity. Strong and prolonged thumb sucking, can cause an upward and forward force onto the anterior aspect of the maxillary complex.

Subtelny and Sakuda (1964) (7) observed that those instances in which thumb and/or finger sucking is the obvious cause of the open-bite, there will be an inadequate development of the anterior alveolar processes, as well as incomplete eruption of incisor teeth.

If an open bite exists, it is not unusual to see the anterior aspect of the tongue enter the open-bite area during swallowing. It is Subtelny's and Sakuda's clinical impression that in most instances, the tongue is adapting to its own environment, i.e. the thumb or fingers created the orthodontic problem and subsequently the tongue has adapted to that problem.

It has been the experience of many orthodontists that the correction of open-bite malocclusion can occur if the finger or thumb habit is eliminated.
Abnormal Tongue Function

The cause and effect relationship of abnormal tongue function and anterior open-bite is not clear.

Four factors may be considered:

1. activity
2. posture
3. age and growth
4. adaptability
   Graber (1972)

1. Activity Neff and Kydd (1966) (11) felt that the presence of the tongue between the teeth alone was not enough to induce an open-bite. Whereas Proffit and Mason (1975) (12) considered that the resting position of the tongue was more important in open-bite aetiology than the actual swallowing activity.

Proffit (1978) (13) furthermore, showed that the tongue pressure is actually less in patients with open-bite. According to Subtelny and Sakuda (1964) (7), a patient with an open-bite malocclusion can be shown to demonstrate abnormal activity of the tongue, as well as abnormal tongue size, as a causative mechanism in the malocclusion.

Central nervous system disorders following injury disease or mal-development of the brain, contribute to impaired neuromuscular control of the tongue. Gershater (1972) (9), carried out a survey on children in special schools. He established that there was a
higher incidence of open-bite malocclusion among mentally retarded and Downes Syndrome children. This observation may be related to the lack of necessary muscular control for proper function of the jaw, tongue, mouth and the swallowing pattern. This type of tongue activity is known as an endogenous tongue thrust.

2. **Posture:** altered postural relationship of the head, jaw, and tongue may be related to open-bite. If there is difficulty in nasal breathing, adaptations which aid mouth breathing include a forward positioning of the head, a lowering of the mandible and a low and forward tongue position. (7)

Tongue thrusting has been indicated as an aetiological factor in open-bite; other contributing factors include, respiratory problems, such as allergies, enlarged tonsils, congested eustachian tubes, enlarged adenoids (14), nasal cartilage excess, deviated septum, soft tissue proliferation of the nasal passage, atelactasis and related pulmonary disturbances.
Rix (1946), suggested that the "teeth apart" swallow was a residual infantile behaviour and maturation might be delayed in the presence of upper respiratory obstruction and infection. He pointed out that with nasal obstruction the "teeth together" swallowing is uncomfortable, and that if upper respiratory troubles were dealt with early the behaviour might tend to change. However, Gwynne-Evans and Ballard (1948), believed it to be an infantile pattern of behaviour due to some delay in maturation of neuro-muscular behaviour at the cortical level, and not related to upper respiratory infections.

Gwynne-Evans held the view that the atypical swallowing behaviour, with its peristaltic-like contraction of the circumoral muscles, is an expression of a "visceral type" of behaviour, the muscles of the face occupying a developmental position between the somatic musculature controlled by the nervous system and the visceral musculature controlled by the autonomic nervous system (23).

True macroglossia is rare, though in certain cases tongue size as well as excessive activity may be an important factor in the aetiology of anterior open-bite. (Graber, 1972) (15).
3. **Age and Growth Factors.** It is a well established fact, that the tongue is disproportionately large in relation to the skeletal jaws, at the time of birth. This discrepancy in proportional size may persist for a considerable period during the earlier years of life. A disproportionately large tongue and its resultant posture would cause and maintain an open-bite for a number of years. (7).

Therefore it may well be better to wait for adequate growth of the skeletal jaws, which will hopefully, permit the tongue to lie within the dental arches. It is not until this adequate growth has occurred that an open-bite may spontaneously correct itself. (16)

4. **Adaptability:** Abnormal form will elicit abnormal function, which may manifest itself as a compensatory function of the tongue. A patient with a backward rotating growth problem, a normal overbite of zero, and lips barely adequate to cover the teeth comfortably, will require extreme activity of the tongue and mentalis muscle to effect the necessary circumoral seal during swallowing.

When the patient's morphology requires abnormal muscle activity e.g. tongue thrust, the activity is likely to enhance rather than cause the open-bite tendency. (Speidel et.al, 1972) (17)
Trauma or pathology

Trauma, or pathological conditions involving the growing condyle, may alter the degree or direction of growth of the mandible, resulting in anterior open-bite. A fractured neck of the condyle, if not adequately reduced, results in healing of the fracture with the mandible in an open-bite relationship to the maxilla (18) Other pathological conditions giving rise to anterior open-bite, may include cleft palate and acromegally.

Iatrogenic factors

Schudy in (1964) (19), introduced the terms "Hyper and hypodivergent" in relation to facial growth patterns. Moving molars either occlusally or distally in a patient with a hyperdivergent growth pattern will result in an anterior open-bite of iatrogenic origin.

Other common "mistakes" include the use of flat anterior bite plates, where the starting overbite is already reduced, and, for bilateral expansion of narrow maxillary arches, when treating posterior cross-bites.

The common feature of these "errors" is the wedging open effect produced upon the mandible in the intercuspal position.
As one can see from the above data, the aetiology of an anterior open-bite is not a simple problem. It is in fact multifactorial in aetiology. (Watson 1982) (20).
CHAPTER III

GROWTH

In Brief
Summary diagram showing the distribution of periosteal resorptive surfaces (dark stipple) and periosteal depository surfaces (light stipple). Note the growth reversals (indicated by arrows) between the mesial and distal (anterior and posterior) parts of the maxillary arch and between the nasal and premaxillary regions of the face.

The mandible, maxilla, and bones of the cranium grow by two separate but interrelated types of growth movement. (1)

a) the movement of direct growth enlargement and remodelling produced by deposition and resorption.

b) the movement of displacement of bones as they enlarge.

The cranium follows the neural growth curve while the middle and lower anterior parts of the face follow the bodily or general growth curve. (2)

Cranial Base

There are four growth sites in the cranial base. (2), (3)

a) inter-sphenoidal synchondrosis (ceases at birth)

b) intra-occipital synchondrosis (ceases by age 3-5 years)

c) spheno-ethmoidal synchondrosis

d) spheno-occipital synchondrosis

Synchondroses are what remains of the primary cartilagenous skeleton of the cranial base. Unlike a suture, this remaining area of growth cartilage is theoretically capable of growth under pressure. (4)

All the synchondroses apparently grow by the endochondral mechanism. (3) Postnatal growth of the cranial base is at the spheno-ethmoidal and spheno-occipital synchondroses. The contribution of the
spheno-ethmoidal syndondrosis has been variably assessed. Coben (5) suggests, and others indicate a range of up to 25 years. (2)

As it grows, the anterior part of the cranial base elongates and the attached nasomaxillary complex is moved forward in this process. Its major contribution may have been made by the time the first permanent molar erupts, as by this age, the anterior cranial base does not increase much in size. (4)

During growth, the most prolific bone deposition and elongation occurs in three main sites:

a) the posterior tuberosity which grows in a posterior direction;

b) the alveolar margins which grow in a vertical direction;

c) the maxillary body including the sutures, which because of their oblique orientation grow in both a vertical and horizontal direction. (6)

The resultant is the downward and forward movement of the nasomaxillary complex. According to Enlow (1982) (7), the face, particularly the nasomaxillary process, bears an intimate relationship to the cranial base, because the floor of the cranium serves as a template upon which the face is formed.

From birth to adulthood, the mandible appears to grow in a downward and forward direction, as it
enlarges in overall size. In fact the mandible grows in a backward and upward direction. (8)

The mandibular condyle functions as a growth centre up to the end of the second decade, during which it is replaced by bone in endochondral ossification. (4)

Growth of the skull is a matter of the face increasing relative to the brain case, and it swings downward and forward from its early retrusive position. (2)

The face grows in height at a greater rate than in width or depth. Faces get longer as we pass from infancy into adulthood. "Growth is generally completed first in the head, then the width of the face, and last in length or depth of the face". (9).
The Role of Facial Growth
in Anterior Open-Bite

Basic studies of facial growth have demonstrated that faces grow in a downward and forward vectoral direction. This vector is composed of a given increment of vertical growth, and a given incremental antero-posterior growth. Mandibular growth rotation is a term used to describe the rotational change of the mandible relative to cranial structures resulting from growth (Bjork, 1969) (1) (Figure 1 & 2)

This growth rotation takes place as a result of two separate processes.

a) Differential vertical relationship between condylar growth and the combined sutural and alveolar growth of the maxilla and mandible. If the combined vertical growth of the nasal, zygomatic and frontal sutures of the maxilla and the vertical growth of both the maxillary and mandibular molars exceed the vertical component of condylar growth, the mandible rotates clockwise. (Bjork, 1969) (1)

Schudy (1963, 1965) (2)(3) wrote that "clockwise rotation" is a result of greater vertical growth at the molar region than at the mandibular condyles, and extremes of this condition cause open-bite.

b) Direction of the growing mandibular condyle which could be vertical, sagittal (posterior and superior), or any direction in between. (Bjork, 1963) (4)
Internal rotation of the mandible, i.e., rotation of the core relative to the cranial base, has two components: A, rotation around the condyle, or matrix rotation; and B, rotations centered within the body of the mandible, or intramatrix rotation. (Redrawn from Bjork, A., and Skieller, V.: Eur. J. Orthod. 5:1-46, 1983.)


Figure 1
Superimposition on implants for an individual with a normal pattern of growth, showing surface changes in the mandible from age 4 to 20 years. For this patient there was \(-19\) degrees internal rotation but only \(-3\) degrees change in the mandibular plane angle. Note the dramatic remodeling in the area of the gonial angle, with a net resorption over this period of time. This surface remodeling or external rotation compensates for and conceals the extent of the internal rotation. (From Bjork, A., and Skieller, V.: Eur. J. Orthod. 5:1-46, 1983.)


Figure 2
Shows the author's concept of growth of the mandible. These drawings were made from composites from the computer in a sample of patients aged 5, 8 and 13 years. Another sample was used for a study of patients in males alone, 18 years of age. For this method of superpositioning, pogonion and the anterior border of the ramus at the coronoid crest are employed. These points represent the true nonresorbing cortical bone which can be located reasonably well with cephalometrics. The vertical apposition at the superior border of the ramus is displayed. It will further be noted that the occlusal plane is moving with Xi point which moves progressively upward. It also will be noted that the lower incisor moves upward and forward as resorption and remodeling and thinning of the alveolar process occurs. The lower molar is seen to move in an upward and forward direction, which accounts for the creation of space for the second and third molars.

(From: Ricketts RM: The principle of arcial growth of the mandible. Angle Orthod 1972;42:381.)
The clinical significance of these findings is apparent. Extreme variation in mandibular rotation can be seen as a factor in solving or compounding an existing problem. Anterior open-bite existing with backward rotating growth patterns will get worse. Growth, once assumed to be a valuable aid and correction of occlusal variations, is a liability when it occurs in the wrong place and in the wrong amount.

Skeletal open-bite pattern can be expected to get worse with continual growth. Droel and Isaacson (1972) (5), noted that backward rotating growth patterns had a more superiorly placed glenoid fossa. This effectively shortens an already shorter ramus.

Recent work has suggested that the tongue grows at a different rate to the surrounding dento-alveolar and muscular tissues, and that, although relatively large in the young child, the tongue exerts relatively less influence as the child enters puberty and adulthood. This altered balance of "influence" may explain why some "tongue thrust - open -bite" cases become self correcting, and why, even in so-called endogenous tongue thrust cases, the open-bite after reduces with age. (Cooke, 1981) (6)

Vig and Cohen (1974) (7), measured tongue size relative to the intermaxillary space at age ten, and in the adult, and found that the tongue became
relatively smaller, a fact ascribed partly to the
descent of the tongue during normal growth and partly
to the differential rates of growth of the
skeletodental and muscular elements.

According to Proffit and Mason (1975) (8), the
tongue grows steadily and approaches maximum size at
or near the age of eight, having followed the neural
tissue growth curve. In contrast, the mandible
follows the general body growth curve, and as growth
continues the tongue is able to adapt a lower position
within the mandibular arch with less tendency to
"thrust" between the incisor teeth.
CHAPTER IV

Morphology of Skeletal Open-Bite
Tracing of a cephalometric head plate showing some of the skeletal disharmony. A steep mandibular plane and excessive vertical dimension to the anterior aspect of the face are noted in conjunction with an open-bite malocclusion.


Figure 1
Extra-Oral

Profile: The patient presents with either straight, convex or concave facial profile. A characteristic feature of skeletal open-bite is the increased lower facial height. The lips at rest are incompetent and a conscious effort is required to hold the lips together with obvious evidence of muscle strain. During swallowing an active contraction of the orofacial musculature will be evident. There is a steep Frankfort mandibular plane angle and a marked antegonial notch is present. (1)

Frontal: When viewing the patient from the front, increased length of the face will give the impression of a long thin face. The upper lip is short resulting in a high line, and when smiling the patient show an excess of upper teeth and gum.

Intra-Oral

As a result of the active pressure exerted by the lips during swallowing, there is a tendency to mild crowding and flattening of both arches in the incisor region. The inclination of the incisor teeth will vary, depending on the antero-posterior relationship of the mandible to the maxilla.

In the severe skeletal open-bite cases, the only dental contact between the upper and lower arches, is in the region of the second permanent molars. The
tongue lies forward and gives the impression of being rather large. True macroglossia is rare.

During swallowing an anterior tongue thrust is evident as the tongue moves forward and laterally to fill the open inter-dental area and forms a seal with lips. The gingival condition is hypertrophic due to continual mouth breathing. (1)

Cephalometric Characteristics

The antero-posterior relationship of the mandible to the maxilla will vary in individual cases. The characteristic features of skeletal open-bite are related to the vertical dimension.

Maxilla

There is some disagreement in the literature regarding the height of the maxilla. Subtelny and Sukuda (1964) (2) and Sassouni and Nanda (1964) (3) claimed that in anterior open-bite cases the maxillary dental height was greater at both the incisor and molar levels, while Nahoum (1971) (4) and Nahoum et.al. (1972) (5) found no significant difference in the measurements from maxillary molar cusp tips to palatal plane or to S-N plane.
Mandible

A short ramus is present together with an increased gonial angle and a marked antegonial notch. (1) The dento-alveolar height in the molar region is reduced while in the incisor region it is increased.

The body of the mandible may be long or short depending on the tendency to Cl.II or Cl.III skeletal pattern.

In Occlusion

There is an increased total anterior facial height, measured from nasion to menton. This is due to an increase in lower facial height measured from anterior nasal spine to menton. (Richardson, 1969) (6)

The ratio of the upper anterior facial height to lower anterior facial height (UFH/LFH) serves as one of the diagnostic criteria. The normal UFH/LFH ratio was given by Nahoum (1975) (7) as 0.8, open-bite <0.7, and closed bite >0.9. Posterior facial height measured from sella to gonion is reduced. (Nahoum et.al. 1972) (5)

Nahoum (1975) (7) pointed out that two occlusal planes should be described: A maxillary occlusal plane from the intersection of the molar cusps to the incisal edge of the upper incisor, and a mandibular
occlusal plane, from the molar cusps to the incisal edge of the lower incisor.

In skeletal open-bite both the palatal plane and the maxillary occlusal plane are tipped upwards anteriorly, while the mandibular occlusal plane is canted downwards.

**Morphology of Dental Open-Bite**

Extra-Oral

There are no characteristics extra-oral features associated with this malocclusion. In the presence of an increased overjet there will be a convex profile with incompetent lips.

Intra-Oral

Maxillary Arch

The shape of the maxillary arch will show the characteristic features related to the aetiology. If the malocclusion is due to a foreign body (pencil, pipe) being held passively between the incisor teeth, then the open-bite is localised to the particular teeth involved: they will fail to erupt to the occlusal level of the other teeth in the arch.

When the malocclusion is an a result of a thumb sucking habit, then the upper incisor teeth may be proclined resulting in a V-shaped upper arch. Due to
this increased buccal pressure exerted on the molar teeth by the cheeks during sucking, there is a narrowing of the arch in the molar region. (Moyers, 1963) (8)

The mandibular incisor teeth are slightly depressed and lingually inclined.

In occlusion, the anterior open-bite has a characteristic appearance. The opposing molars and premolars are in contact, the canines may or may not be in contact; the lateral and central incisors are in frank open-bite. The mouth has the appearance of a "fish mouth". The open-bite is limited to the incisor region as opposed to the skeletal open-bite which extends to the molar region. On swallowing there is a characteristic anterior tongue thrust with the tongue coming forward into the incisal opening to form a seal with the lower lip.

Cephalometric Characteristics

Maxilla: There may be a decrease in the vertical height measured from the incisal edge of the upper incisor to the palatal plane. In the presence of an increased overjet, the cephalometric analysis will show both angular and linear evidence of proclined upper incisor teeth.
Mandible: Skeletal features related to vertical dysplasias will be absent. Retroclined and crowded lower incisors may result from a thumbsucking habit. The alveolar height in this region is not increased.

In Occlusion: As pernicious thumb sucking is one of the commonest causes of this type of malocclusion, cephalometric analysis shows an increased incidence of skeletal Cl.II jaw relationship (large ANB angle). This is related to the action of the thumb encouraging the forward movement of the maxilla while restraining the mandible.

If the two occlusal planes are drawn as suggested by Nahoum (1975) (7) the maxillary occlusal plane will be tilted up anteriorly, while the mandibular occlusal plane will show little change from the normal.
CHAPTER V

ANTERIOR OPEN-BITE TREATMENT
It is well-recognised that anterior open-bite malocclusion is one of the most difficult orthodontic problems with regard to correction and stability. (1) Sassouni and Nanda (1964) (2) recognised that a dental malocclusion has a better prognosis than a "dento-skeletal malocclusion".

In view of the close relationship of orthodontic relapse to the continuing action of the original aetiological factor, it is essential that a careful examination and appraisal of the case be undertaken and an attempt made to identify the aetiologic factors.

There are four modalities of treatment:

1. orthodontic mechanotherapy
2. surgical therapy
3. myofunctional therapy
4. combination of two or more of the above.

Each of these has its place in the approach to treatment. It is important to determine which form of treatment is the most suitable for each individual case.

Dental Open-bite

Fortunately these represent the largest group seen in orthodontic practice, and although often difficult in terms of management, both the child and the parent are relatively amenable to treatment.
The prognosis in this type of case is dependent on the ability to halt the action of the factor inhibiting the full eruption of the incisor teeth.

It is a common experience in the majority of habit open-bite, once the thumb sucking habit is controlled, the anterior open-bite closes on its own. However, in an unknown smaller number of cases, the anterior open-bite with the associated maxillary distortion (including high vaulted palates, cross bites and tilted palatal planes), overjets and incisor malalignment could not spontaneously resolve themselves. (3) This is a simple procedure accomplished by the use of fixed appliances together with vertical elastics. (1)

The palatal crib either as a removable or fixed palatal bar, is the most common form of appliance used for the control of a thumbsucking or tongue thrusting habit. (Subtelny and Sakuda 1964) (3). (Figure 1)

The specific details of the appliance are of little significance. The important feature is that by some mechanical means the thumb is physically prevented from taking up a comfortable position in the mouth. A prerequisite for the success of this treatment approach is the willingness of the patient to break the habit. (1) For a patient who sincerely wishes to stop sucking and for whom the habit is an
Figure 10  The maxillary palatal crib. The extensive vertical dimension permits complete encompassment of the open-bite area.

"empty habit", the appliance will act as a reminder and will help the child to break the habit. However, when the thumb sucking is a "meaningful habit", and is important to the child, then a more psychologically orientated treatment approach should be adopted. (4).

Where the presence of an anterior tongue thrust associated with an anterior dental open-bite has been established, then the procedure of choice is to treat the malocclusion on the assumption that the tongue thrust will disappear when the open-bite has been reduced.

Any form of tongue therapy should be postponed until after the treatment has been started. Active myotherapy alone can be considered although positive results with this procedure have not been clinically demonstrated in sufficient numbers to give evidence that such therapy can effect a correction or prevent a relapse following appliance therapy (Proffit and Mason, 1975) (5)

According to Nahoum (1975) (6): Diagnosis of a growing child is different from that of an adult. The adult presents us with a fait-accompli. There is no hope for improvement without active treatment. With a child, however, in some cases, minor changes in the growth pattern may facilitate treatment, so that a
Surgical technique for correction of long face syndrome with open-bite. Similar procedure is used for correction of vertical dysplasias without open-bite. A, Typical dental, skeletal, and facial features of long face syndrome with mandible in centric relation and lips relaxed. Note prominent nasal dorsum, obtuse nasolabial angle, large distance between apices of maxillary teeth and nasal floor, excessive curvature of maxillary occlusal plane, high mandibular plane angle, lip incompetency, retropositioned mandible, open-bite, contour-deficient chin, and Class II malocclusion. B, Plan of surgery: Le Fort I osteotomy to reduce facial height, close open-bite, level maxillary occlusal plane, reduce incisor tooth exposure and lip incompetency, and close residual extraction spaces. Horizontal osteotomy of chin designed to increase chin prominence and decrease vertical height of mental symphysis. Premolar teeth have been extracted to facilitate correction of crowded and malaligned teeth by orthodontic means. Extraction spaces are closed only the amount necessary to align anterior teeth. Cross-hatched areas indicate planned horizontal and vertical ostectomy sites. Arrows indicate planned directional movements of anterior and posterior maxillae and chin. Amount of bone to be excised is determined from cephalometric prediction studies and mock sectioning of study casts (Figs. 3 and 4) before surgical intervention. C, Repositioned maxilla is fixed to the piriform rims and zygomatic buttresses with transosseous wires; suspension wire from infraorbital rim to maxillary arch wire provides additional support to maxilla.


Figure 5

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poor prognosis can become a favourable one. Growth makes the difference.

If one considers the first and second molars as a fulcrum, 1 or 2mm of additional posterior facial ramal height growth would mean a resolution of an open-bite in some cases.

Patients with a craniofacial malformation should not be treated by elongation of anterior teeth. Dentoalveolar height is finite. Even if the bite were closed, facial improvement would be limited except through favourable growth or surgical intervention. (6)

Perhaps the main contraindication to extrusion of anterior teeth is the risk in many cases of creating or exacerbating a "gummy smile", with a high lip line. (32)

The dental aspects of open-bite can be resolved cosmetically, but the fact that facial, neuromuscular and pharyngeal components are of equal importance, means that other disciplines must be considered, for example, surgical removal of tonsils and adenoids, where obstruction with consequent lowered tongue and jaw posture has occurred during active growth. (6)

When it is evident that enlarged tonsils and adenoids are aetiological factors in open-bite
malocclusion, positive preventive measures can be taken. Unfortunately orthodontists are placed in a difficult position, they usually don't encounter the open-bite problem during the early stages of development before a permanent skeletal deformity has been established. The family physician ultimately takes the responsibility for advising the surgical procedure for the removal of lymphoid tissue.

Steel et al. (1968) (7), indicated three reasons for surgical removal of tonsils and adenoids.

1. Repeated attacks of tonsillitis

2. Hypertrophy of tonsil and adenoid tissue, to the extent of obstruction of Eustachian tubes and nasal or oral airways.

3. Evidence that the tonsil harbours chronic infection.

A fourth reason which is rarely acknowledged or considered by the medical profession is the presence of large hyertrophied tonsils and adenoids which may adversely influence the growth and development of orofacial structures.

Linder-Aronson (1970) (8), in his studies of Swedish children who underwent adenoidectomy, found that the children in the adenoidectomy group had a significantly longer anterior face height than control children. They also had a tendency toward maxillary constriction and more upright incisors.
The removal of the lymphoid tissue permits the muscles of mastication to function in a more normal environment. 
(8) Nevertheless, this does not always mean a resolution of the anterior open-bite. The reason is that the abnormal compulsive functional pattern of deglutition becomes deeply entrenched, and as a result, the muscles have to make compensatory adjustments to a new function and environment. Myofunctional therapy or a mechanical appliance may be used to correct the residual problem, once the aetiological factor, has been removed.

Orthodontic therapy

Where the severity of the case doesn't warrant surgical intervention, some improvement may be obtained by means of orthodontic teeth movement. For example, molar depression: here treatment must be aimed to prevent further eruption of the molars if not depress them.

With maxillary high pull head gear, there will be control or even suppression of the eruption of the teeth, which will minimize the clockwise rotation of the mandible or even enhance an anti-clockwise rotation: this happens by allowing the growth of the condyles to be expressed in a forward direction since the growth at the molars is minimised or eliminated. 

(9). (Figure 2)
Direction of orthopedic traction should be determined by treatment objectives. For mandibular prognathism, pull should be upward and backward, 1, roughly along vector from symphysis to condyle. For correction of anterior open bite, direction of pull should be as, 2, vertical as possible.


Figure 2
Children with excessive lower face height can be treated successfully by restricting posterior eruption, which allows mandibular growth to be expressed in an anterior direction as the mandibular rotates counterclockwise.


Figure 3
These tracings demonstrate a good response to functional appliance treatment designed to control vertical development with posterior bite blocks in a child with excessive lower face height. The superimpositions indicate that no posterior eruption occurred and all mandibular growth was directed anteriorly. Face height was maintained and anterior eruption closed the open bite.


Figure 4
Active Vertical Corrector

The Active Vertical Corrector, is a simple removable or fixed orthodontic appliance that is an adaptation of the bite-block therapy, but it is an energized bite-block. The energy system is obtained by the repelling force of Samarium cobalt magnets which are sealed in stainless steel capsules. The method of action is reciprocal intrusion of the maxillary and mandibular teeth. This movement results in the autorotation of the mandible and open-bite correction. (10).

Vertical Elastics

One of the treatment procedures recommended is the use of vertical elastics to erupt the maxillary and mandibular anterior teeth. This procedure is based on the assumption that there is vertical underdevelopment of the anterior alveolar arches, resulting in an inadequate eruption of the incisor teeth. If there is an inadequate vertical dimension to the anterior dentoalveolar processes, then there may be merit in this use of vertical elastics. However, in the average open-bite there is already supraeruption of the upper incisors and molars, while the mandibular incisors and molars were not found to be infraerupted. Elastic therapy might elongate anterior teeth which are already beyond the limits of eruption, and, consequently will return very rapidly to the open-bite position. (3).
Intermaxillary elastics

Intermaxillary elastics may cause extrusion of teeth and changes in the facial vertical dimension. Ricketts (1957) (11) reported a 2.5 to 3.3mm elevation of the lower 1st molar after use of Cl.II elastics. Anchorage preparation in the lower arch as a prerequisite for the use of Cl.II elastics is an answer to the side effects of their use. (9)

Extraction

If extractions are indicated due to associated dental crowding, the extraction should be limited to the distal regions of the dental arch. This procedure is desirable in permitting mesial movement of the more posterior teeth, as an aid in closing of the anterior open-bite.

Usually, the extraction of 2nd bicuspidis, or less often the extraction of 1st permanent molars, might permit sufficient anterior movement of the more posterior teeth away from the region of the short posterior normal height.

In certain instances it may be desirable to prevent eruption of the 1st molars and to extract 2nd molars, if one of the other is supraerupted. It should be noted that there is a general tendency as a consequence of orthodontic correction to elongate maxillary lingual cusps. This axial inclination must
be altered to raise the lingual cusps so as to permit
greater upward and forward mandibular closure prior to
achieving occlusal contact.

Orthopaedic Approach

Since the development of dento-facial
orthopaedics it has become possible with the use of
heavy forces to alter the direction of growth of the
mandible. Graber and Swain (1975), have claimed that
orthopaedic forces, (usually over 1000gm) applied over
long periods (3-8 years), to the growing mandible, can
minimize unfavourable growth vectors, and encourage
growth to express itself in a more forward direction,
(or downward in Cl.III cases).

Graber also believes that the buccal teeth in
skeletal open-bite cases are "over-erupted", and that
the interocclusal space (free-way space) is reduced or
vertically absent. Using various chin caps or webbing
devices (Cooke, 1980), orthopaedic forces are applied
from below the chin (often in combination with acrylic
posterior bite plates) in an attempt to "close down"
the over-erupted buccal segments, and to modify the
direction of the chin during jaw growth.

Worn during periods of active mandibular growth,
considerable clinical success has been reported, and
analogies drawn to the well documented detrimental
dental and orthopaedic effects produced by the Milwaukee Brace. (30)

It is further claimed that as the bite "closes", spontaneous adaptations occur within the masticatory neuromuscular system, allowing for changes in the length of the muscles supporting the mandible.

Functional Appliances

Another approach is the use of functional appliances which include posterior bite blocks. The purposes is to inhibit the eruption of posterior teeth, and vertical descent of the maxilla.

The appliance can be designed with or without positioning the mandible anteriorly, depending on how much mandibular deficiency is present. Regardless of whether it is brought forward in the working bite, the mandible must be opened past the normal resting vertical dimension.

When it is held in this position by the appliance, the stretch of the soft tissues (including but not limited to the muscles), exerts a vertical intrusive force on the posterior teeth. In children with anterior open-bites, the anterior teeth are allowed to erupt, which reduces the open-bite. (12)

Frankel, has been using and developing clinical orthopaedic appliances for over twenty years. His
appliances, he claims, actively alter the shape of the oral functioning space, by using acrylic shields, which alter the position and behaviour of the enveloping muscular walls. A wide range of stable, skeletal and muscular improvements have resulted from Frankel appliances in open-bite cases. (Frankel 1980)

Frankel's experiences in skeletal open-bite treatments and his own studies, led him to support the findings of Simpson (1976), that the supra-hyoid muscles were involved in these cases, in helping to achieve an anterior oral seal and that this has the secondary effect of producing a "tongue thrust", as the hyoid bone (and therefore the base of the tongue) moved. When the weak lip musculature was retrained to achieve lip competence (using the Frankel appliance), the supra-hyoid muscles ceased to be involved, and the tongue thrust ceased.
Surgery

Severe skeletal open-bite malocclusions are impossible to correct by orthodontic means alone. (McNeil 1973).

Surgical correction offers the advantage of direct elimination of the skeletal defect, rather than indirect compensation for the defect by tooth movement.

The dental occlusion resulting from surgical correction alone maybe less than ideal, because of preexisting teeth malpositions and muscular patterns. Combined surgical and orthodontic treatment circumvents many of the limitations of individually applied treatment modes, but it it dependent for its success on careful conjoint diagnosis and treatment planning. (17)

The various operative procedures available to the surgeon for the correction of this dentofacial deformity are:

1. Anterior maxillary osteotomy
   Wassmund (1927)

2. Posterior maxillary osteotomy
   Kufner (1971)

3. Le Fort 1 down fracture technique to free the entire maxilla
   Bell (1977)

4. Mandibular (dento-alveolar) surgery
   Kole (1959)
According to Proffit (1986) (14) problems of excess face height which are usually accompanied by severe open-bite, were not treated in a reliable manner until the 1970's. At present the maxilla can be moved up quite successfully, but can be positioned downward with less predictability.

The mandible can be moved up or down anteriorly, but cannot be moved at the gonial angle with stability. As a general guide, this means that long faces are best treated by intrusion of the maxilla. This method allows the mandible to rotate around the condyle, thereby reducing the mandibular plane angle and shortening the face. (14)

Maxillary Surgery

The contemporary surgical approach involves maxillary intrusions after removal of bone from the lateral walls of the nose, sinus, and nasal septum. It is important to shorten the nasal septum or free its base so that the septum is not bent when the maxilla is elevated.

The inferior turbinates can be partially resected if needed, to allow the intrusion, although this procedure is rarely necessary. The overall facial height is shortened as the mandible response by rotating upwards and forward, altering both its occlusal and postural positions. A longitudinal study
has shown that this type of maxillary intrusion provides stable correction of long face problems, because the maxilla does not tend to move back down, post surgically. (Phillips, Schellhex, Proffit et al. 1985) (21)

Mandibular Surgery

Patients with a long face, skeletal open-bite, and an anteroposterior mandibular deficiency often have a short mandibular ramus. Surgery to reduce the mandibular plane angle, and close the open-bite, by rotating the mandible posteriorly and up anteriorly, has been found to be highly unstable, because the fulcrum for rotation is the posterior teeth. This rotation lengthens the ramus, and stretches the muscles of the pterygo-mandibular sling. (14)

The instability is attributed primarily to lack of neuromuscular adaptation in these powerful muscles.

Occasionally, anterior open-bite occurs in a patient without vertical maxillary excess. (Kole 1959)

Kole devised a procedure for treating anterior open-bite problems by elevation of the mandibular alveolar segments and interposition of a graft taken from the lower border of the chin, thus shortening the face height. This is apparently, a very successful alternative method for closure of anterior open-bite,
when maxillary impaction surgery is not indicated. (26)

In an anterior open-bite type of malocclusion, the age of the patient has an important bearing on the treatment plan. With continuing growth there is a progressive backward rotation of the mandible and a corresponding increase in the severity of the open-bite (Bjork, 1969, 1972) Surgery is consequently seldom undertaken before the end of the pubertal growth spurt. (14)

Prognosis

It is important to distinguish between a purely dental open-bite and the skeletal form. As a general rule the more the skeletal elements contribute to the aetiology of the malocclusion, the poorer the prognosis for orthodontic treatment. Therefore the success diminishes as the open-bite extends externally and posteriorly into the canine, premolar and molar regions.

Although in most instances the extent of the interincisal opening has a direct correlation, Nahoum (1977) (29) suggested that the ratio of the upper anterior facial height to the lower anterior facial height determines the prognosis of orthodontic correction of anterior open-bite.
Retention

The retention plan for an open-bite malocclusion, should be based on the causative mechanism in each case. If the open-bite was due to a thumb or finger sucking habit, the mere cessation of the habit may be sufficient to maintain the result. Since it has been observed that the tongue will adapt to a new environment, provided that the environment is maintained within physiologic limits, the closure of the open-bite may be sufficient and may preclude the necessity for retention.

In the skeletal open-bite cases, all possible effort should be exerted to keep the bite closed. Continued use of high pull headgear may be helpful in preventing molar eruption. Tooth positioners may helpful in keeping maxillary and mandibular molars depressed, if worn for a sufficient length of time.

Nemeth and Isaacson (1974) suggested the use of a Milwaukee Brace type of appliance to maintain or reduce the combined sutural and alveolar growth of the mandible in an attempt to allow posterior facial height increases to produce Bjork's (1969) Type II or Type III, forward mandibular growth rotation.

In maintenance procedures, rotation would occur about the incisal edges of the lower anterior teeth, to hold the anterior rotations, whereas in closure of
the anterior open-bite, rotation might occur about the molars. The removal of third molars should be considered to prevent any opening of the hinge upon their eruption into occlusion. Depending upon the severity of the original skeletal anterior open-bite, the retention should be worn until growth of the jaws is complete. (14)
In conclusion:

The treatment of patients with anterior open-bite is difficult, and is often unsuccessful. It requires good judgement and skill. Treatment should attempt to correct the skeletal as well as the dental dysplasia. Unfortunately the means for accomplishing these ideal goals are not readily available, since we are severely limited in identifying and in eliminating the causes of these malformations (that is, genetics, growth, neuromuscular, habit, etc). (29)

According to Subtelny and Sakuda (1964) "In evaluating "open-bite", one must consider the skeletal and muscle relationships. If treatment is attempted considering one factor alone - the opening between the anterior teeth - the results may be disturbing and disastrous.

The orthodontist must be cognizant of, and wary of, all the variables involved. There may be strong clues as to whether or not treatment is advisable. For example, the extent of deviation in the skeletal pattern will give strong indications of the potential for success or failure, that is barring the introduction of prosthetic or surgical procedures".

With surgical procedures there may be complications, such as loss of tissue related to inadequate post surgical blood supply or prolonged
parasthesia of the lower lip. (26). Relapse may occur when the incorrect surgical procedure is used to correct the dysplasia, as for example, if a mandibular advancement procedure only, is performed on a high-angle deficiency case, with vertical maxillary excess and open-bite. In contrast excellent skeletal stability has been demonstrated by the simultaneous superior repositioning of the maxilla and mandibular advancement. (26)

According to Proffit (14), the contemporary approach to treatment of skeletal open-bites involves a team effort. In almost all cases, an oral and maxillofacial surgeon and an orthodontist are involved as primary team members. Because of the largely adult patient population, and the impact of surgery and orthodontics on tissue support, a periodontist is needed for regular consultation, and a person qualified to do psychological evaluations and counselling, should be identified for consultation if the need arises.
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