A Biological Approach to Diagnosis, Mechanics and Treatment of Vertical Dysplasia

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Probably no discipline in medicine and certainly none in dentistry devotes more time to growth research than orthodontics. The amazing benefits of this growth to the clinician have been well-documented by researchers since the 18th century. Yet equally conspicuous is the fact that this fantastic wealth of information is still consigned to the laboratory and for the most part is ignored by the clinician. How else can one explain the continued rampant use of extraction therapy in growing children, serial extraction in children with great growth potential, the increasing use of orthognathic surgery in younger and younger patients and, to the point of this article, the prevalent notion that the vertical dimension is one of orthodontics' greatest challenges.

Certainly clinical articles in the current orthodontic and surgical literature could lead the reader into despair regarding the vertical dimension. While this author agrees with much that is written, there are several points of major disagreement. I cannot subscribe to the theory that the vertical dimension is very difficult if not impossible at times to manage without surgery, that when an individual has more than ideal anterior face height there is a vertical problem, that Kloehn cervical gear is totally contraindicated in cases with vertical problems and that vertical surgical correction should be routinely done in growing children.

If we examine the above hypotheses in the light of growth, it is not only possible to arrive at differing conclusions but also in subsequently utilizing growth in treatment to totally dispel these beliefs.

In reality the vertical dimension should be the easiest of the three dimensions for the orthodontist to deal with. It grows the most in magnitude and for the longest period of time. It would seem that the greater the potential for a structure to increase in size, the greater the opportunity to effect a change in that structure. And the longer the potential for change, the longer the opportunity to make that change.

Why has the vertical dimension been such an enigma? It would seem that the answer is also to be found in the literature. A perusal of same would indicate that, for the most part in the past and still to a large extent in the present, traditionally the vertical dimension has been largely ignored! And when finally discovered, the most commonly used mechanics are frequently totally contrary to biological needs.

In anterior deepbite cases a deliberate attempt is usually made to erupt posterior segments whether with bite plates, leveling arches, light wire techniques and various modes of intermaxillary elastics. Is it small wonder that our retention literature discusses the great amount of relapse seen in overbite corrections?

In anterior openbite cases the most frequent attempts for correction have been found to be extraction of posterior teeth and the use of anterior vertical elastics. We read in our retention literature that if orthodontics

Read at the March 1980 reunion meeting of the Univ. of Illinois Alumni Association.

has a more significant relapse problem than deepbite cases, it's the openbite case.

The theme of this presentation is that vertical is beautiful and all the questions raised in the preceding paragraphs will be addressed and hopefully most of the answers will have merit.

When we speak of vertical dimension in regard to an orthodontic case, we must distinguish that portion which is skeletal and that which is dental. Should we attempt to increase vertical, to decrease it or leave it as found? A correct diagnosis will give us this information.

A Tweed triangle, a Steiner or Margolis analysis will not suffice in present day diagnosis as they are primarily tooth oriented with minimal regard to a skeletal assessment. Just as we assess denture characteristics in all three planes of space, so must the skeletal pattern be appraised in three planes. There are some excellent analyses to permit this. The Downs, Coben, Ricketts, and Sassouni are notable. My favorites are the Downs and the original Ricketts.

These two analyses, used in concert, pinpoint anteroposterior and vertical skeletal and dental dysplasias and to some extent suggest the existence of transverse abberations. They are also very effective in predicting mandibular growth potential. This information along with a study of mandibular morphology from the headplate should give the clinician all the information needed in making a sound assessment of the case regarding need for skeletal and dental corrections.

The Coben coordinate system of analysis is probably the most outstanding of all analyses in separating and identifying skeletal and dental anomalies.

While many consider the vertical problem to be excessive anterior facial height, in my opinion the true vertical situation is one of deficient posterior facial height. It is possible to have a case with normal anterior facial height that is an extreme vertical problem because of the deficient posterior facial height, the height of the ramus. It hardly seems necessary to have analyses comparing ratios between anterior and posterior facial heights to determine whether a true vertical problem exists as vertical dysplasia is easily recognized.

A face with a striking vertical abnormality has remarkably consistent and predictable findings; one can always expect to see: 1) poor facial depth, 2) short posterior face height, viz., a short mandibular ramus, and further in the mandible there is antegonial notching, 3) a body with deficient height at the molar area and excessive height at the symphysis, 4) poor depth to the symphysis compared with the height, 5) lack of a chin button and 6) an anterior slope to the anterior surface of the symphysis.

Noticeable facial height with adequate depth is esthetically a good face and mechanically a problem of minimal consequence, orthodontically and orthopedically. Anterior height, whether excessive or normal, without depth is a problem because such a face invariably has an inadequacy of posterior facial height. The mechanical treatment of this latter group will be considered later.

Management of the vertical dimension has been questionable. To increase it, clinicians have used bite plates, leveling arches with multibanding, stretched every conceivable configuration of elastics between the arches, etc. To decrease vertical dimension dentally, orthodontists have used vertical elastics on anterior openbite cases and again the reten-

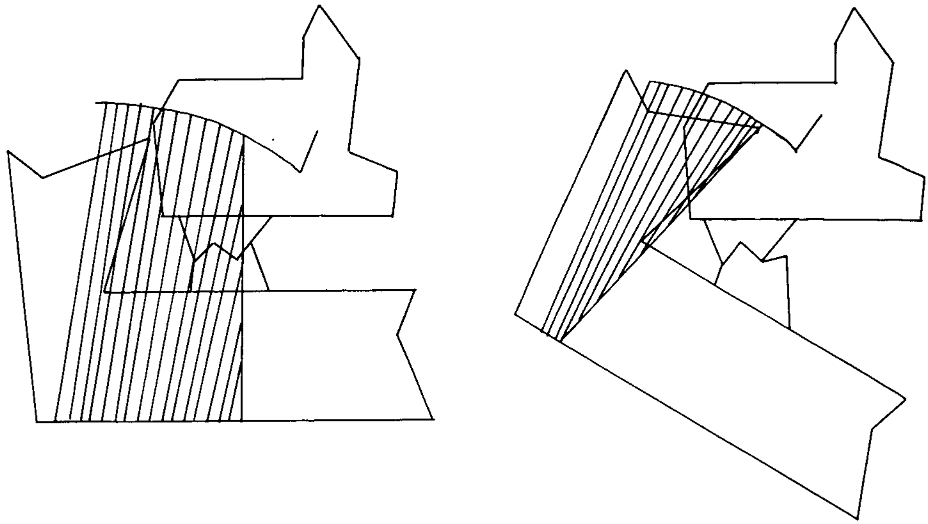

Fig. 1 On the left is the graphic of a hypodivergent skeletal type and right the hyperdivergent type.

tion literature despairs that anterior openbite cases are perhaps the greatest relapse problem. The answers to these problems are really not too difficult. All that must be asked is 1) How is the patient being treated? (2) What is the effect of what is being done? In the first instance vertical has been increased by infringing upon freeway space. I believe it is time to acknowledge that John R. Thompson was correct in 1946 when he said such management was a perilous act. Having always had the greatest respect for Dr. Thompson, I vowed early in my orthodontic life that I would rarely, if ever, attempt to open deep anterior overbite by erupting posterior teeth, but would rather depress incisors or prevent their eruption. Having done this, I find overbite relapse has become virtually nonexistent.

In the case of anterior openbite many orthodontists have overerupted incisors instead of attempting to intrude buccal segments. It is small wonder that the incidence of relapse is so great.

I was additionally influenced by the many articles on the deleterious effects of the Milwaukee brace such as overclosing the bite. It seemed reasonable that the same principle with a less cumbersome device would be most beneficial in treatment of skeletal hyperplasia.

In a 1964 publication Sassouni[1] describes the skeletomuscular differences between the skeletal *deepbite* case and the skeletal *openbite* case. Figure 1 is a graphic representation of Sassouni's astute observations. He observed that in skeletal hypodivergence the vertical chain of masticatory muscles, the masseter and internal pterygoid, course is essentially a vertical path with the short, thick-bellied muscle masses well ahead of molar resistance thus serving to keep the buccal segments depressed and promoting a horizontal growth of the skeletal pattern.

In the hyperdivergent skeletal type he visualizes this same sling of vertical musculature as being long and spindly and coursing obliquely downward and backward. The mass of the muscle is well behind the molar resistance thus it does *not* serve to keep the buccal segments depressed and hence promotes vertical development.

The obvious clinical inference that could be made from these observations is that reattachment of the vertical masticatory muscle sling to a more anterior point on the body of the mandible should be an ideal way of redirecting growth in the skeletal openbite type. Alas, to date this approach has proven unsuccessful as the reattachment migrates posteriorly to the area of original attachment.

It almost seems obvious that, if the skeletal openbite or hyperdivergent type is to be successfully managed, one must artificially apply an anterior muscular-like force to intrude posterior teeth. It is further visualized that such mechanics are interfering with posterior alveolar growth, preventing the descent of the maxilla, moving it superiorly and perhaps even changing mandibular morphology by redirecting growth.

If the anterior openbite is strictly dental, then obviously the habit or environmental factor must be eliminated. The scope of this paper will not permit more than a brief observation of the futility of myofunction therapy in this regard. Myofunctional therapy can be dismissed as a legitimate treatment modality for tongue-thrust swallow on the basis that the concept violates a basic physiologic law, viz., that a reflex act cannot be modified by cortical activity. During the course of a day most swallows are reflexive rather than voluntary. The greatest indictment against myofunctional therapy is that not one successfully treated case has ever been published where myofunctional therapy was the only variable tested.

It is the author's intent to describe the rationale and mechanics he uses in the treatment of: a) dental deep bite, b) skeletal deep bite, c) dental openbite and d) skeletal openbite.

Before continuing, some comments regarding Kloehn cervical gear are indicated. I would like to state emphatically that, in my opinion, Kloehn cervical gear is the most important appliance in the orthodontist's armamentarium. Perhaps with abuse it might produce some of the effects Merrifield,[2] Cross,[3] Root,[4] and others attribute to it. The three greatest abuses in the use of cervical gear are to have the outer bows too short, directing the force straight back or downward and back, and not expanding the inner bow regularly. Even if these mistakes are made, it is doubtful that a well-controlled study would show much, if any, permanent harm being done in most cases.

In twenty percent or less of the skeletal openbite cases Sassouni describes, the tipping down of the palatal plane, the opening of the mandibular plane and "Y" axis, would probably be permanent because the musculature is inadequate to rescue the pattern from the insult.

If cervical anchorage is employed as Kloehn describes it, one should experience minimal difficulty. Kloehn has always advocated a long outer bow bent superiorly 10 to 20° or higher from the horizontal for the favorable torque effect this has on the upper molars and the entire maxilla. It can thus be made to tip the palatal plane up in front. To this I have added a lever arch and cradle elastic for even greater efficiency. Their uses will be illustrated later.

To demonstrate the proper use of a Kloehn cervical, the case in Figure 2 was selected. This young female displayed excess gingiva when smiling. She was also an extreme skeletal Class II. Those who consider Kloehn cervical gear contraindicated in such cases will probably be further shocked when other factors are considered.

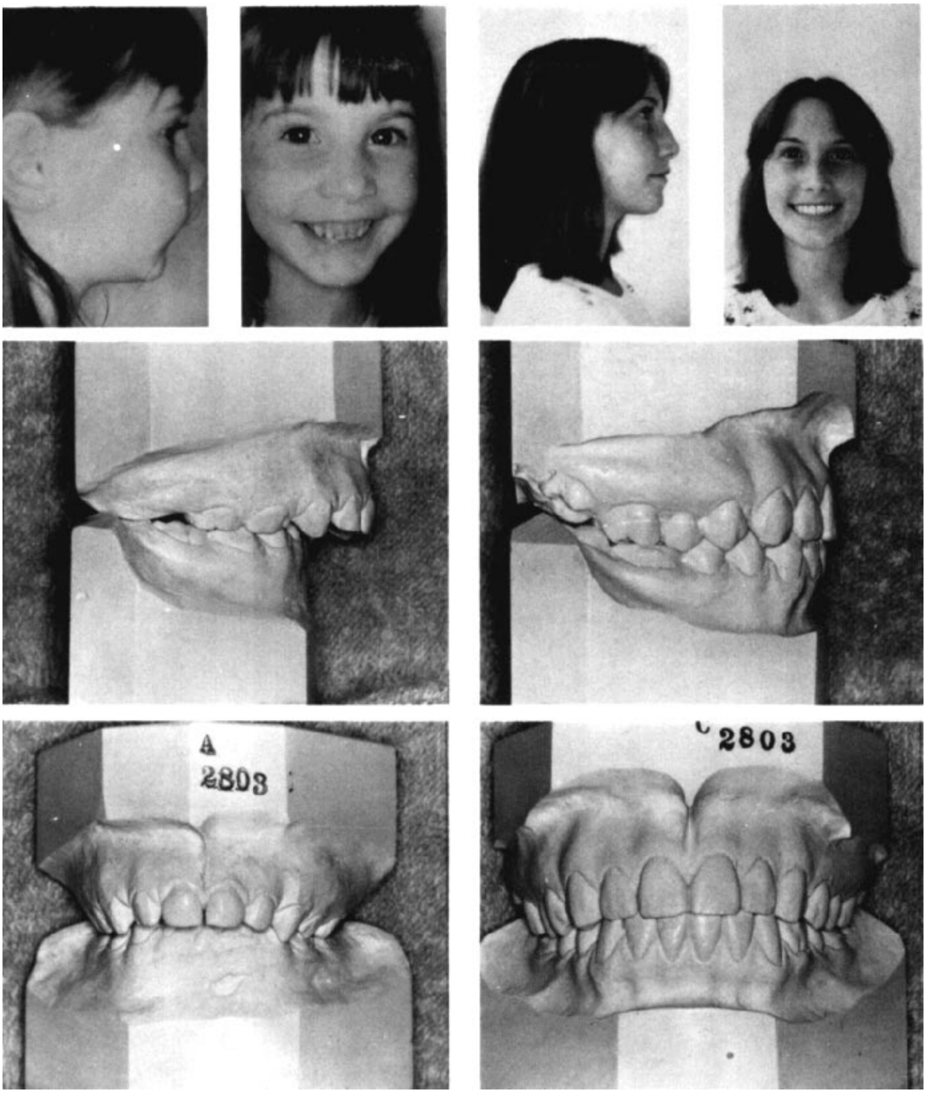

Fig. 2 Pre- and posttreatment records of patient L.R.

L. R. was a relatively high angle case with a 32.5° Frankfort mandibular plane angle. Only Kloehn cervical gear was used in her orthopedic extraoral management. She was treated over a period of five years. About 18 months of this time was in resting phases. This is the only case in my remembrance ever started in the early mixed dentition due to the unrelenting insistence of the mother. The patient made only 35 visits during this entire period of time. The first records were made when she was four years old, however treatment was not started until age 6.5 years. This was one of the very few full treatment cases I have ever begun before dental age 10.5.

The sequence of management was as follows: 1) 1.5 years of Kloehn cervical gear with a force of 12 to 16 ounces of pressure per side; 2) a rest period of approximately six months; 3) reinstituted cervical gear for another nine months; 4) a rest period of one year; 5) conventional guiding treatment using cervical gear with a partial strap up of upper anterior teeth at the time the upper canines started to erupt. At the time the intraoral archwire was placed it was thought that the dental arch was unitized and represented sufficient anchorage for a force level of greater orthopedic potential. Thus the force per side was increased over a three month period to approximately 32 to 40 ounces per side.

Treatment was essentially one arch in that eight teeth were banded in the upper, namely, the first molars and the six anteriors. In the lower arch only the first molars were banded and a holding arch was placed for the last 16 months of treatment. Figure 2 compares the earliest models of the case with the latest taken six years after treatment at age 17.5. The upper retainer had been discontinued two years at the time the recent models were made; the lower fixed lingual was still in place.

Compare further the recent smiling photograph (Fig. 2) with the original and note the excellent change in dentolabial esthetics resulting from a concept of growth oriented mechanics which stresses bite opening by interfering with incisor eruption rather than encouraging eruption of posterior teeth.

The beginning headplate in Figure 3 was made at four years of age and for a child of that age the mandible had fair to good development. The important thing was that the mandible possessed excellent characteristics which portend of equally excellent future development.

The tracings in Figure 3 irrefutably demonstrate an orthopedic change

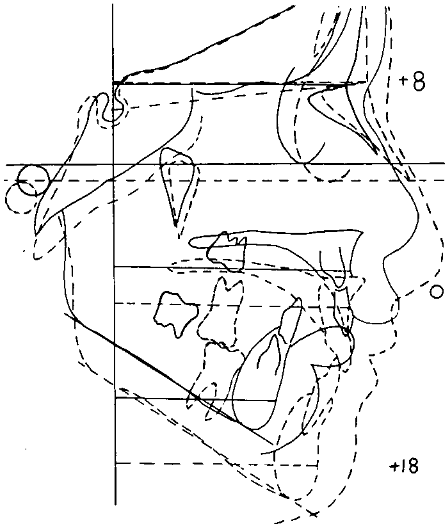

Fig. 3 Superimposed on SN registered at S of pretreatment and posttreatment tracings of case L.R. showing the accumulated changes resulting from orthopedic-orthodontic treatment and growth.

of the highest order. During the 7.5 years period of time illustrated the maxilla moved downward but not forward as a result of literally sliding the maxilla down and back on the undersurface of the cranial base while the mandible continued its uninhibited downward and forward growth. The net result was an exceptional 18 mm horizontal change in the relationship of the denture bases.

Brodie,[5] Lande[6] and others have shown that in Class I and Class II cases nasion and point A advance at similar rates during growth. Since nasion grew forward 8 mm had this case not been subjected to a relatively heavy orthopedic force, the maxilla and point A would be 8 mm forward of their present positions.

In all probability this face now has greater vertical development than if not treated by a maxillary displacing orthopedic force. As it is doubtful that growth can be taken away from the total, it would seem that the growth appropriated from the horizontal dimension was redirected into the vertical dimension. And as long as increase in anterior facial height is balanced by a similar increase in posterior face height, such an added increment of vertical must be considered favorable.

Figure 3 represents the largest change in convexity I have ever witnessed. The change in facial plane, angle of convexity and A-B plane relationship almost defy probability as does the 9 mm improvement in point A to facial plane and the 11.5° change in the ANB angle. In spite of these spectacular changes the relatively steep mandibular plane angle opened only one degree. This case was selected to demonstrate the comparatively minimal adverse effect Kloehn cervical gear has on the vertical dimension if it is properly used. While the Kloehn gear might temporarily increase the mandibular plane angle in some cases, it readily recovers in most of these cases within six to 12 months. You cannot keep a good mandible down. If menton moves inferiorly by treatment mechanics, the musculature is adequate to rescue the pattern from the insult. Posttreatment records will show a return to the original mandibular plane and "Y" axis or an improvement thereof.

Another point of interest in this case was the presence of a tongue thrust swallow. The thrust was effectively overcome by the use of lingual tongue spurs added to the patient's lower molar to molar fixed retainer. Their use is detailed elsewhere.[7,8]

Extraoral anchorage has been with the orthodontic profession at least since Jackson published a series of cases treated by headcap in his 1904 text book.[9] In 1936 Oppenheim[10] published his famous case of the actress treated by headcap therapy. But it was not until the papers of Kloehn were published in the late '40's[11] and early '50's[12] that it achieved much popularity. Kloehn, of course changed anchorage from occipital to cervical. Even then this recognition was long in coming as many clinicians did not properly prepare their patients regarding the importance of cooperation. Thus, many failed to have any success with the appliance.

It was not until the '60's that Kloehn cervical gear traction was employed by a representative number of clinicians with the necessary confidence that the appliance was effective, and the necessary conditioning of the patient to make it succeed.

But due to the passion of the American orthodontist to change things, the modifications made in the appliance and its use again led to problems.

Kloehn advised that the outer face bow be long enough to extend roughly to the ear or well behind the first permanent molar attachment for the inner bow. He further recommended that the outer bow be bent up, off the horizontal, to prevent excessive tipping and extrusion of the molar teeth. He thus had excellent control over the occlusal, palatal and mandibular planes with little if any adverse effect on the vertical dimension while accomplishing the intended improvement in anteroposterior dimension.

A few have gone so far as to condemn the use of Kloehn cervical gear completely and have advised a return to the original Oppenheim concept of using occipital pull exclusively. One certainly can agree that the high mandibular plane angle case is very well-suited to the use of occipital pull headgear, but such a case probably occurs no more than fifteen percent of the time that Class II correction is needed.

Nature has been very kind to the clinician who has increased the verti-

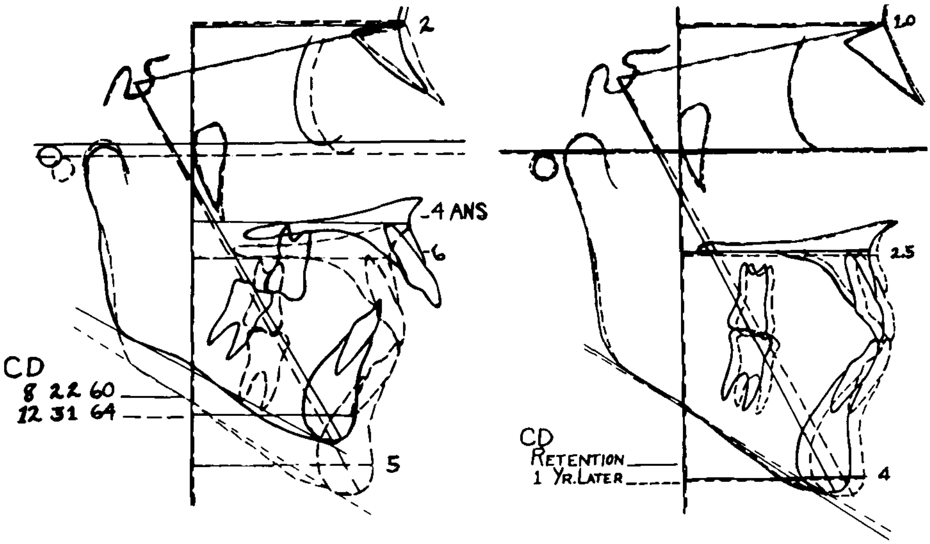

Fig. 4 Left, pretreatment and posttreatment headplate tracing to show opening of the "Y" axis and FMP angle following cervical traction therapy. Right, posttreatment headplate tracing compared with one taken a year later to demonstrate the closing of the "Y" axis and FMP angle.

cal dimension in his Class II cases by the misapplication of cervical gear. Since approximately eighty percent of our cases have good to excellent mandibles, which implies an equally good musculature, even with careless mechanics the muscles of mastication will not tolerate the skeletal and dental bite opening produced. Consequently, within a few months following treatment the bite, skeletal and dental, returns to its original vertical dimension.

I consider Kloehn cervical gear to be the most important appliance in the orthodontist's armamentarium for the very simple reason that most orthodontic cases need anteroposterior correction of the maxilla or maxillary dental arch and there is no better means of achieving this than the use of cervical gear to modify the growth pattern of the maxilla and the eruption of the teeth in a growing child and the teeth in the anteroposterior and vertical planes in the adult.

Figure 4—left represents tracings of headplates of an orthopedic Class II case made before and after treatment. Note again how the maxilla was displaced considerably downward and backward with significant increase in the mandibular plane angle and "Y" axis. The mandible obviously possesses excellent morphology and should thus recover. Figure 4—right shows the same case one year later; note the obvious and totally expected improvement in the "Y" axis and mandibular plane angle. It hardly appears likely that the maxilla grew forward 2.5 mm and the mandible 4 mm. It would seem that having released the maxilla from the orthopedic restraint of 32 to 40 ounces or more per side resulted in a tissue recoil with the maxilla "relapsing" horizontally forward, thus encouraging a counterclockwise upward and forward rotation of the mandible. A more likely indicator of maxillary growth is seen in the one millimeter forward growth at nasion. Point A

probably came forward a like amount with growth and the remainder as a result of discontinuing the compressive orthopedic force.

At least seventy-five to eighty percent of our patients have good to excellent mandibles. I would challenge anyone to show permanent vertical change in this type of mandible no matter what the orthodontic mechanics. In Class I and Class II the single most important characteristic of a favorable mandible is the length of the body; the longer the better. Considering the body the nearer a 1:1 ratio exists between body height at the molars and at the symphysis, the better the mandible. One would further like to see a near 1:1 ratio between depth and height of the symphysis and, as Björk pointed out, it is very desirable to have a posterior slope to the anterior surface of the symphysis or a chin button.

An excellent mandible usually has a good gonial angle indicating a ramus of favorable height and depth. Another advantageous characteristic is a relatively thick condylar process given off at such an angle to produce a favorable vector of growth.

Twenty percent of patients have fair mandibular morphology and may not need vertical control; however, it is probably best to use it. In the indifferent or fair mandible the above-mentioned characteristics are less favorable in total or in part. For example, the gonial angle may be slightly open leading to an increased MP angle with poorer symphyseal morphology.

Probably less than five percent of patients have poor mandibles characterized by a short body, short ramus, high gonial angle, antegonial notching, excessive height at the symphysis, a forward slope of the anterior aspect of the symphysis and no chin button. Such a case must have vertical control.

The only mandibles you can keep down are (1) skeletal openbite cases in all three classes (of course this is almost always undesirable and (2) deepbite skeletal Class III cases. Happily this is almost always propitious since the increase in lower face height and lessening of effective mandibular length would be most helpful in improving the pattern. The Class III case apparently possesses a tremendous freeway space and thus readily tolerates skeletal bite opening.

In high MP angle cases, occipital pull headgear or combination occipital-cervical gear is indicated. However, I have found limited orthopedic value in the use of only occipital pull headgear. The drawing in Figure 5 represents on the left the effect of delivering a force to the maxilla to try to move it upward and backward against the cranial base. Apparently skeletal base structures are highly resistant to change other than that which is intrinsic to the structure phylogenetically and morphogenetically, e.g., the mandible has resisted most orthopedic manipulation. We cannot grow it. We cannot stop it from growing. We can only redirect its growth. So too, when pushing directly against the cranial base by directing a force to the maxilla upward and backward, we see only dental changes and perhaps some inhibition in the descent of the maxilla. When directing the force horizontally to the maxilla as on the right in Figure 5, the maxilla is free to slide on the under surface of the cranial base with no change in the base and probably little or no change in the body of the maxilla. Most of the maxillocranial sutures are oriented in planes roughly comparable to the plane of the cranial base. This orientation readily accommodates the

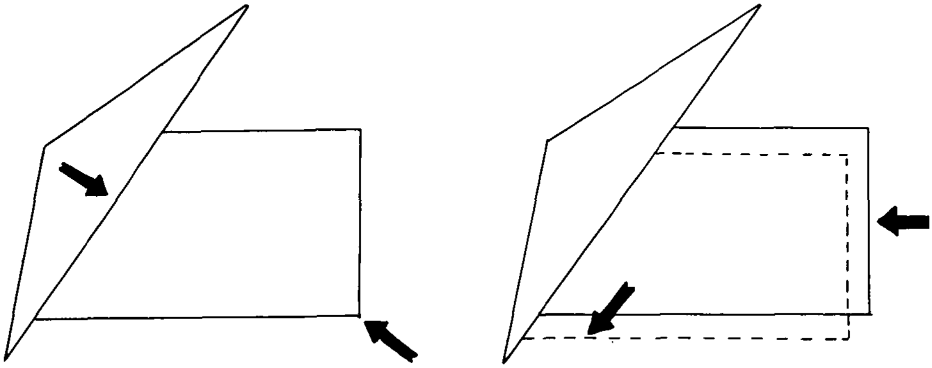

Fig. 5 Schematic drawing of the cranial base and maxilla to illustrate response to directional orthopedic force.

slide of the maxilla.

The apparent cephalometric change seems to be due to downward and backward displacement of the entire maxilla with an obvious lessening in the horizontal dimension and an increase in the vertical dimension. The question now becomes is this increase in vertical dimension acceptable? The answer would seem to be yes in all cases except skeletal openbite and in these cases it is necessary to apply a vertical-pull chin cup as in Figure 6 to prevent opening of the mandibular plane and "Y" axis.

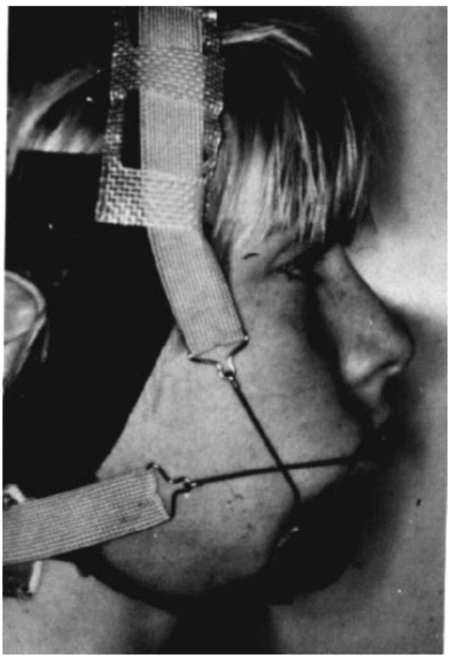

Fig. 6 Profile photograph to demonstrate the application of the combined use of the vertical-pull chin cup and Kloehn cervical gear.

The vertical force from the chin cup does not prevent the maxilla from being displaced downward and backward, as it should so respond in accord with the amount of vertical dimension added by growth at the mandibular condyle. The increase in posterior facial height with the growth of the ramus accommodates the repositioned maxilla. The maxilla assumes the space that the erupting teeth would ordinarily occupy. Of course, due to the infringement of the maxilla, the posterior teeth not only fail to erupt but are also usually depressed as a result of the chin cup force.

Dental Deepbite

The growth oriented concept of treating dental deepbite consists of recognizing the gross mechanics of vertical facial growth and tooth eruption and merely altering them by the application of orthodontic mechanics to interfere with normal processes in accord with the assessed needs of the case under consideration.

In the simplest terms during facial growth the mandible grows downward and forward away from the maxillary cranial complex and the teeth are in continuous eruption at a rate consistent with the rate at which the jaws are separating to maintain a relatively constant freeway space. Thus it would seem most logical that, if one is to be consistently successful in treating dental deepbite, mechanics should be employed that will interfere with the eruption of the incisors, primarily the upper incisors.

The case demonstrated in Figures 2 and 3 was treated by this concept regarding anterior bite opening. The facial photographs in Figure 2 speak eloquently of the excellent dentolabial esthetics achieved by this concept in contrast to some of the very poor dentolabial esthetics seen often when multiple elastics are stretched between the arches in certain techniques. Invariably, with such anchorage-poor techniques, bite opening is achieved by erupting posterior teeth; the posttreatment smile is thus very pink.

Figure 7 illustrates the mechanical arrangement for preventing incisor eruption in the growing child or depressing these teeth in the nongrowing adult. The principle of the lever is used to depress incisors or to prevent their eruption. An archwire spans from molars to incisors. Under most ideal circumstances the eight incisors are banded approximately one year after the start of guiding treatment at the time the upper canines are starting to erupt. It is as if the depressing incisors will meet the erupting canines. This is not to imply these mechanics cannot be used if canines have already erupted; they will work at any age. A 17 × 25 or 18 × 25 ideal archwire is gabled several millimeters anterior to the molar tubes in order that the anterior segment of the wire lies well above the brackets. Thus, when inserted into the brackets it will have a depressing and lingual root torquing effect on the upper incisors. The mesial root thrust on the upper first molars is countered by keeping the outer bows of the headgear at a high level. The archwire must always be secured, whether by cinching or tie backs. It is very synergistic to simultaneously close spaces, torque and depress the incisors. A light two to four ounce elastic is worn from canine hooks on the inner bow of the headgear to engage the incisal wings of the brackets of the four anterior teeth. This supplies a lifting or cradling action to these teeth and enhances torque, depression and to some extent space closure.

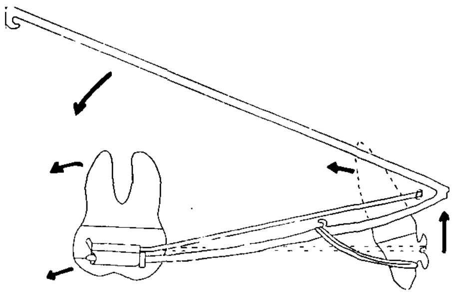

Fig. 7 Schematic drawing of the mechanics used to interfere with upper incisor eruption or to depress these teeth.

Except for adults, most cases require less than twelve months time to achieve overcorrection of the incisal overbite. In the growing patient with minimal convexity (−3 to +1 ANB angle) it is not wise to place a potentially growth restricting cervical gear to the maxilla. The lever arch is utilized as above, but extraoral activation is supplied by a "J" hook high-pull headgear.

The lower incisors frequently require some vertical control in the deep overbite case. In the growing patient merely interfering with their

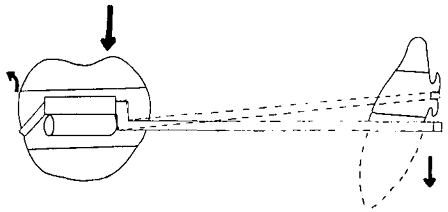

Fig. 8 Schematic drawing of the mechanics used to interfere with lower incisor eruption or to depress these teeth.

eruption is sufficient to accomplish this end. In the nongrower some depression of these teeth is desirable. It is foolish, however, to totally level the lower arch as the curve of spee cannot be permanently treated out of the lower dental arch and to do so automatically builds a relapse factor into a case so treated. Therefore, lower incisors should be maintained or depressed until a mild curve of spee exists in the lower arch. All additional requirements for bite opening should come from upper incisor control. Figure 8 depicts the mechanics used to accomplish lower incisor control.

The function of the lower lever arch is to maintain arch length and to depress lower incisors. The principle of the lever is employed by spanning a 17 × 25 or 18 × 25 archwire from the molar tubes to the incisor brackets. The wire should be cinched back to prevent flaring of incisors. No torque is needed in the anterior segment as the geometry of the arch is ideal to depress these teeth in an upright bodily fashion. The long span of the lever makes the force very light, long acting, and continuous in activity. Forces of occlusion prevent posterior tipping or extrusion of the lower molars. After the incisors are depressed, should canines require depression, they are banded and tied to the arch with elastic thread until depressed to incisor level; then all six lower anterior teeth are secured to the archwire. It requires approximately four to six months to gain sufficient depression of four to six anterior teeth.

If a system of mechanics is successful in treating a nongrower, it should be eminently more successful in treating a growing patient. The models in Figure 9 are those of a male age 22 at the time treatment was initiated. He was treated over a 36 month period of time. To open the bite, incisors were depressed in the upper and lower arches by using the previously discussed mechanics. The upper first molars, the lower left first and lower right second molars and the eight incisors were the only teeth banded during this time. After the incisors were fully depressed, the four canines were banded and depressed by intruding them toward their respective arches with elastic thread. Depression was sequential to not tax molar anchorage. Only after the bite was opened by the lever principle of depressing anterior teeth were additional teeth banded to complete treatment. The photographs in Figure 10 made at age 36, eight years off upper retention, show the absolute stability in anterior overbite correction. Such correction can be routinely expected when it is made by depressing incisors rather than by building relapse into treatment by erupting posterior teeth into the inviolate freeway space.

Skeletal Deepbite

It is unlikely that in Class I and Class II skeletal deepbite cases or hypodivergent cases that a permanent opening of the skeletal pattern can be achieved. Temporary most definitely, but it is doubtful whether it is permanent.

However, in a growing Class II, Division 2 where skeletal bite opening would be most desirable I place

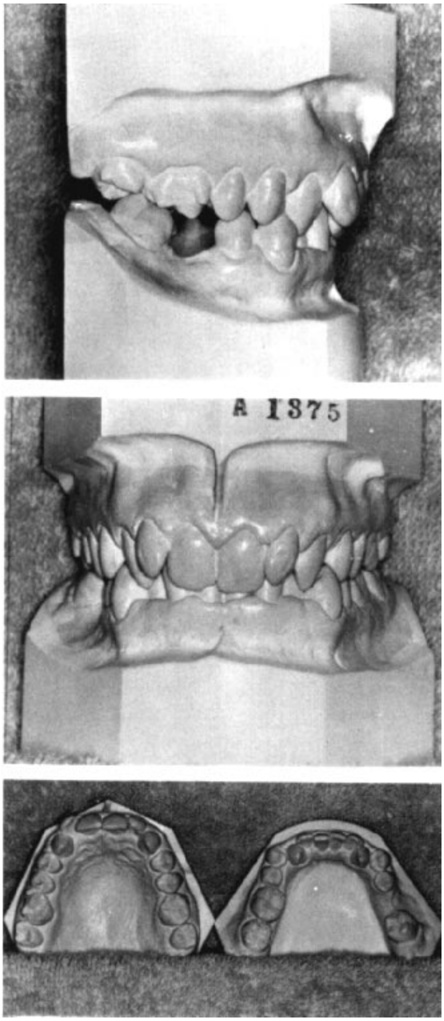

Fig. 9 Pretreatment model photographs of 22 year old male in which anterior overbite was corrected by incisor intrusion.

significant torque in the outer bows of the face bow by bending them superiorly 30 to 45°, the reason being that if only five to ten percent of the induced skeletal bite opening is retained, the pattern has been left better than found. This should be the ultimate goal of all orthopedic treatment. Whatever the skeletal relapse, it is of minimal concern when applying the above discussed incisor vertical control as the incisors will sim-

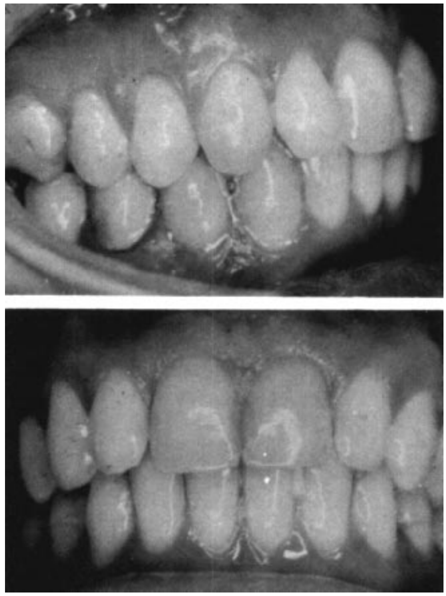

Fig. 10 Recent photographs of patient depicted in Figure 9 showing the excellent stability of the overbite correction.

ply depress additionally as the posterior vertical correction is lost.

The skeletal deepbite Class III case has its own set of rules. Apparently there is an excessive amount of skeletal freeway space and the pattern can be permanently altered in the vertical dimension. I have many longstanding cases that can be offered as proof. Some were recently published.[13]

The headplates seen in Figure 11 are the before and after headplates of an iatrogenically created Class III as a result of early surgical abuse. This case was published in greater detail.[13]

It is obviously a better face because of the astonishing vertical increase in lower face height and the diminished effective mandibular length. This represents another of the many instances where increased vertical is most desirable.

To skeletally increase vertical most effectively it is necessary to loosen

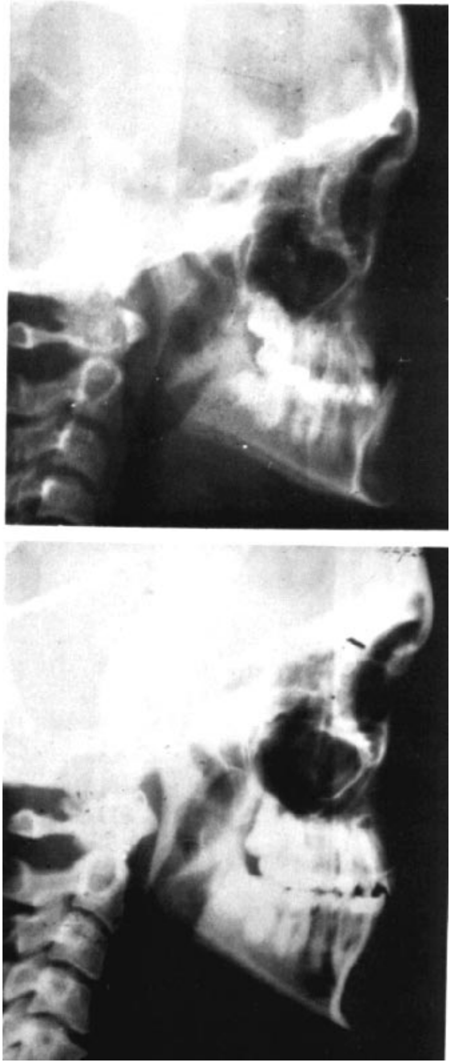

Fig. 11

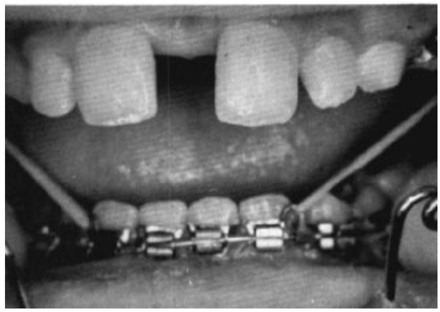

Fig. 12

the maxillocranial articulations by rapid maxillary expansion. The separated maxillae are nevertheless bound into a unit by the stabilized palatal expansion appliance. The maxillary unit is then torqued downward at the posterior end, concomitantly the mandible is forced into a negative rotation. This downward and backward rotation of the mandible results in an increase in lower face height thus achieving the desired goal.

The appliance system used to increase facial height and lessen effective mandibular length is seen in Figure 12. It merely consists of using heavy, about 24 to 32 ounces per side, Class III type traction to the unitized maxilla. The elastics run between the molar area of the palatal appliance and from the canine area of a lower appliance.

Figure 13 is a tracing made from the headplates in Figure 11. Observe the significant mandibular rotation as a result of tipping the maxilla down in back. The increase in menton was 18 mm and pogonion was moved back 9 mm.

The tracing in Figure 14 shows that this vertical skeletal change is completely stable 12 years later and 14 years after treatment. The only retention at this time is a vitallium palatal casting to maintain the transverse cleft palate correction. Obviously this retainer would not be able to resist vertical relapse if such a thing were imminent. Fortunately in skeletal Class III one need have minimal concern for such relapse as it rarely, if ever, occurs.

Skeletal Openbite

In skeletal openbite or hyperdivergent cases I have used three basic approaches to treatment depending

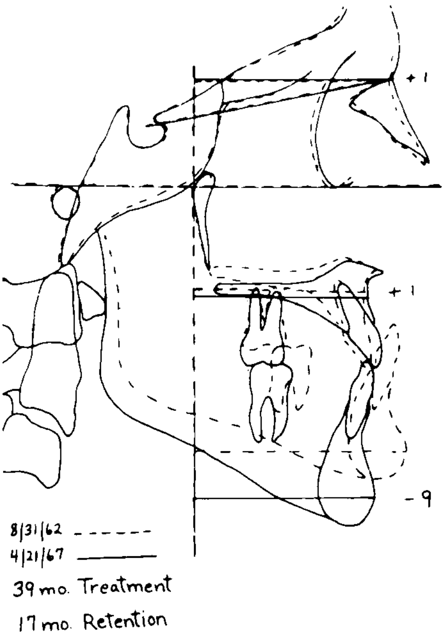

Fig. 13 Superimposed tracings of headplates prior to treatment and 17 months into retention. Notice the striking increase in skeletal vertical.

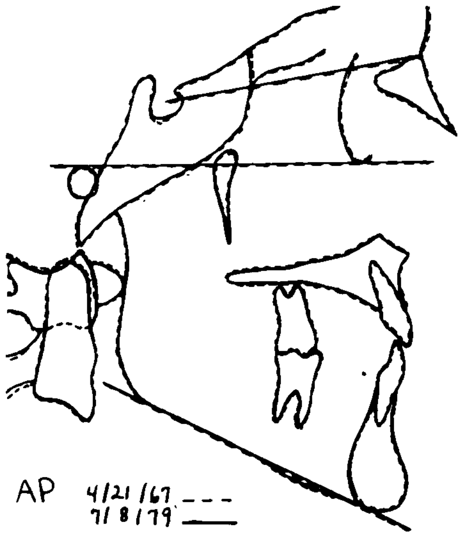

Fig. 14 Superimposed tracings of headplates taken 12 years apart to show the stability of the skeletal vertical change.

on the severity of the condition. If a Class II dental relationship exists but the anteroposterior relationship is favorable and further there is a mild vertical dysplasia as noted by an angle of 30° to 32°, then treatment with face bow and occipital anchorage is definitely indicated. It will not accomplish much vertical correction but little or none is needed. It will effect a dental anteroposterior correction while not worsening the vertical relationship of the jaws. A tooth moving force of 4 to 12 ounces per side is indicated.

If moderate anteroposterior and vertical jaw problems do exist then more substantive measures for correction are needed. Such a case would have an ANB angle of 6° or 7° and a Frankfort mandibular plane angle of 30° to 35°. Since occipital headgear has virtually no orthopedic potential, it is very desirable to use cervical gear with a force of 12 to 24 ounces per side as such a force will impede the forward growth of the maxilla, something that is needed to alter the ANB angle to the 2° to 4° range. The maxilla will probably be displaced downward or surely the vertical component of growth would be stimulated by the action of the cervical gear. Since the pattern should not be made to tolerate such a vertical change, occipital pull headgear in combination with the cervical pull gear should be used as in Figure 15. The force of the occipital gear should be slightly less than or approximately equal to the force from the occipital gear. The net effect of the combination headgear should be to change the moderate skeletal Class II pattern into a Class I pattern with some improvement in the vertical jaw relationship as well as interfering with the eruption of the upper posterior teeth.

If maximum vertical orthopedic correction is desired, it is necessary to place the posterior segments under the influence of a heavy depressing

Fig. 15 Photograph depicting the application of a combination occipital-cervical pull headgear.

force such as the action of a Milwaukee brace with a chin rest. A more simple and logical appliance would be the vertical pull chin cup. This appliance seen in Figure 6 has the potential to intrude posterior teeth in a nongrowing patient and thus cause a positive rotation of the mandible.

If a growing child is subjected to heavy vertical-pull chin cup force, posterior teeth can be depressed; certainly their eruption will be prevented. This in turn prevents posterior alveolar bone growth and the descent of the maxilla. In addition the maxilla can be displaced upward and forward. Finally, it is possible to alter mandibular morphology if the force is active over a long period of time.

In a Class I case with severe vertical dysplasia only the chin cup is required. However, if both a severe anteroposterior and vertical aberrancy exist, then cervical gear is necessary to correct the anteroposterior while the chin cup worn simultaneously will correct the vertical problem.

Cases best served with these mechanics are those with ANB angular differences of 8° to 12° or more and FMP angles of 35° or higher.

If an orthopedic problem is multifaceted the priority of treatment is very important. And this priority is consistent with growth characteristics of the three dimensions.

Since the transverse dimension grows the least and stops the earliest, it is always accorded first priority in orthopedic treatment. The anteroposterior dimension comes next in treatment priority and on the growth scale. Finally the vertical dimension is dealt with last as it grows the most for apparently the longest period of time.

Therefore, if we have a hypothetical case with a severe anteroposterior and vertical dysplasia, Kloehn cervical gear and vertical-pull chin cup are placed concurrently with the initial force on each being approximately 8 to 12 ounces per side. The cervical gear force is increased to 30 to 50 ounces per side over approximately a three month interval of time while the vertical force is kept to a maximum of 12 to 16 ounces per side. To have a heavier force would interfere with the anteroposterior correction due to the reinforcement of the Class II dental occlusion. At the time that the first molar occlusion is just past an end-on relationship toward Class I, the force of the vertical pull chin cup should be stepped up to 40 to 80 ounces per side, thus forcing the teeth into a heavy occlusion. The forced settling of the inclined planes of the teeth enhances and speeds the anteroposterior correction.

Case K. L. is an excellent example

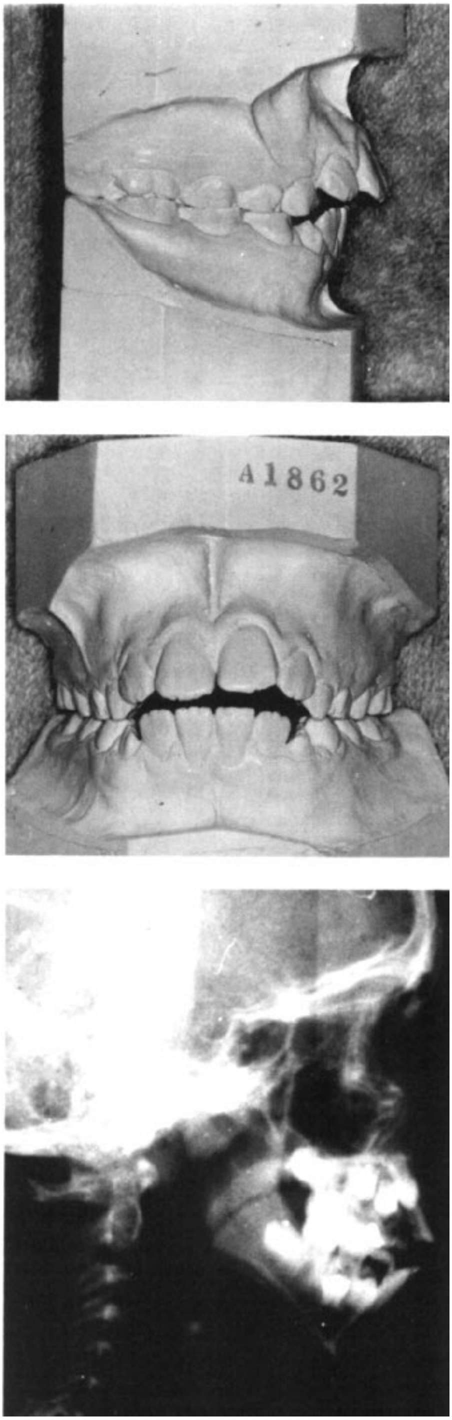

Fig. 16 Records of case K.L. taken prior to treatment.

of much of the foregone commentary. Her headplate and models taken at age 9 are seen in Figure 16. At first glance the situation seems extreme and cephalometrically this appeared to be the case. The ANB angle was 9°, Pt. A to facial plane 9 mm, the FMP angle 40° and the "y" axis 66.5°. Dentally, the interincisal angle was 103.5°, the upper incisor 15 mm ahead of the APo plane, while the lower was 8 mm ahead.

Accordingly, we were dealing with a severe skeletal anteroposterior and vertical problem and also what amounts to a bimaxillary protrusion. I do not consider this case a true vertically distressed case because of relatively favorable mandibular morphology. While the mandibular plane angle is not good, most other aspects are favorable to very favorable. There is excellent posterior face height (ramus), good body length, and good symphyseal morphology. All these predict excellent magnitude of growth as without question mandibular morphology is the key to growth.

The direction of growth is not entirely favorable, therefore the main objective of orthopedic treatment in this case would be to give the mandible a more horizontal vector of growth. The other orthopedic objective should be to reduce the severe skeletal Class II.

The truly distressed vertical condition is that case with poor mandibular morphology with a poor prognosis for growth both in magnitude and direction. Orthodontists should be thankful that this type of case is infrequently found. Far less than five percent of cases fall into this category.

For K. L. the anteroposterior abnormality was managed by the application of heavy cervical gear force.

The vertical redirection of growth resulted from the application of a heavy vertical-pull chin cup force. The denture correction was made by holding both dentures in space while the face grew downward and forward. The vertical dental correction was made in part by excluding the tongue from the interincisal space with tongue spurs. No anterior vertical elastics were used at any time.

Removal of teeth was vetoed because with the above growth-oriented treatment plan it would have served no purpose. It may be necessary to remove third molars at a future date.

The patient was three years in treatment and wore the vertical-pull chin cup for an additional three years in retention. I suspect that during the latter period of wear there was satisfactory but not particularly outstanding cooperation.

The results of treatment are highly significant. Figure 17 shows an esthetically pleasing face in the profile strips. While we did not change a vertical grower to a horizontal grower, the finished profile shows reasonably good balance considering the original condition.

The salient feature of this case was the realization of the objective of redirecting mandibular growth (Fig. 18). The first tracing compares headplates taken about one year before treatment and one made several months into retention. The strong skeletal Class II with excess vertical was changed to an equally strong skeletal Class I with acceptable vertical. For example, the ANB angle changed from 9° to 3° while the upper incisors which were 15 mm ahead of APo were treated to 6 mm ahead and the lower incisors were reduced from 8 mm ahead of APo to 4 mm. In spite of orthopedically moving the maxilla down and back the vertical was decreased as one can see in the closing of the "Y" axis and mandibular plane. Note also the flattening of the occlusal plane and the very atypical position of the posterior surface of the ramus. When tracings are registered on sella and superimposed on SN this surface always seems to move posterior to the beginning surface in subsequent comparisons.

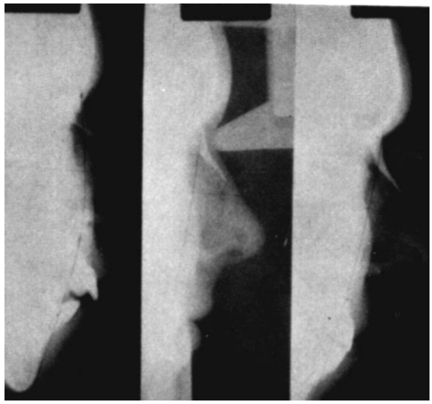

Fig. 17 Profile strips demonstrating K.L.'s profile, pretreatment on the left, posttreatment in the center, and four years later on the right.

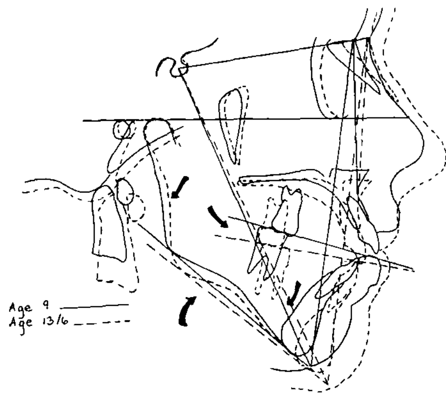

Fig. 18 Superimposed tracings of pretreatment and posttreatment headplates of case K.L. Note in particular the behavior of the ramus.

Figure 19 depicts the changes from posttreatment to four years later about nine months following discontinuance of the vertical-pull chin cup. Note how the pattern continued

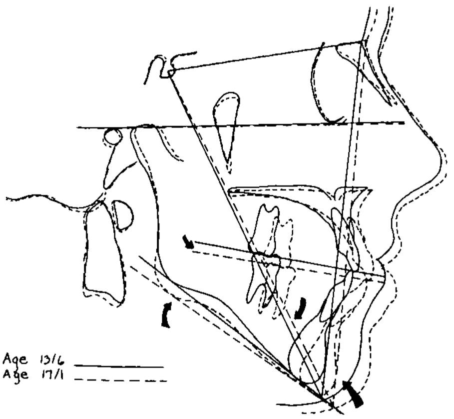

Fig. 19 Superimposed tracings of posttreatment and four year posttreatment headplates of case K.L. Notice the condylar change.

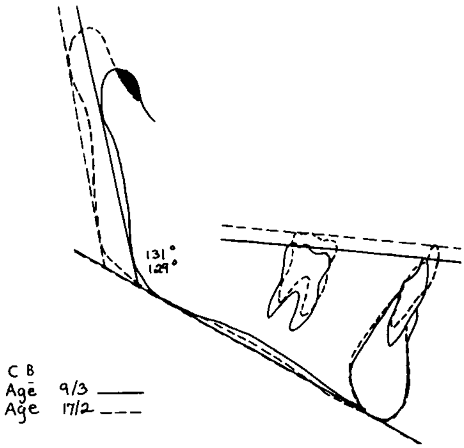

Fig. 20 Superimposed tracings of an untreated female mandible showing the growth changes between ages 9 and 17. Note the expected behavior of the ramus and condyle.

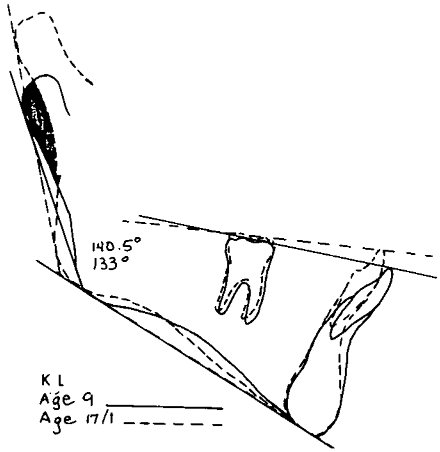

Fig. 21 Superimposed tracing of the mandible of case K.L. showing the growth and treatment changes between ages 9 and 17. Notice the totally different response of the ramus and condyle when compared with the untreated mandible. (Fig. 20)

the strong Class I growth and the improvement of the facial plane, the continued closure of the "Y" axis, and the mandibular plane. Observe the very atypical response of the condyle. The behavior of the ramus and condyle in the tracings aroused the author's curiosity. The mandible was examined in more detail.

To closer examine the mandibular phenomenon several female controls between the ages of 9 and 17 with untreated mandibles were selected. All behaved similarly to the patient illustrated in Figure 20. In this control the ramus and condyle moved upward and backward and the gonial angle closed 2°.

In the treated patient (K. L.) when registering on the symphysis and superimposing on the lower border of the mandible, the ramus and condyle moved upward and forward and the gonial angle closed 6.5° (Fig. 21).

If the control case and our treated case are now superimposed, Figure 22, we can see that both mandibles have similar body characteristics but at the nine year age level there is a considerable posterior divergence in the ramus of the treated case. However, in the 17 year old comparison note how both condyles now lie in the same vertical plane.

The only possible explanation for the phenomenon is that there was a definite change in mandibular morphology induced by the vertical-pull chin cup therapy.

One can speculate as to the mechanism of change. Was this actually a warping of the mandible with the

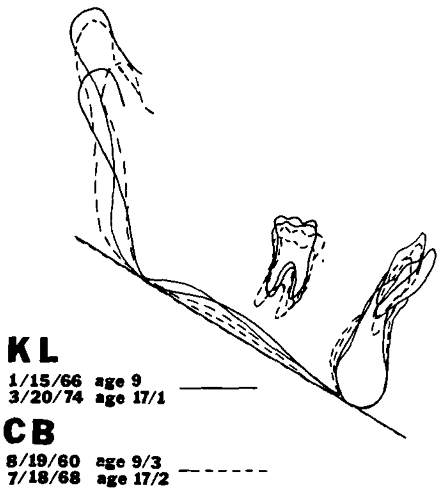

Fig. 22 Superimposed tracings of the mandibles of treated case K.L. and the control case at the ages 9 and 17. Observe that while the rami and condyles start out in different planes of space at age 9 they are in the same plane at age 17.

bending occurring at gonion? As beneficial as this might be, such a happening would be exceedingly doubtful. Did the alteration occur in the ramus? Probably not. It is most likely that most or all the change occurred in the rapidly and substantially growing condyle. In any event it insured a striking and permanently improved skeletal pattern and denture pattern.

Models of the case at age 17 are shown in Figure 23. One may criticize the minimal anterior overbite as gnathologically lacking incisal guidance. There should be no concern for the stability of the openbite correction as no vertical elastics were used in correction. It further appears that the tongue thrust swallow has been overcome and, while it would be preferable to have dental overbite, I am satisfied it is the best I could do for the patient.

As for the expediency of a deep anterior overbite because of the value of incisal guidance, I contend that as a profession we are rationalizing

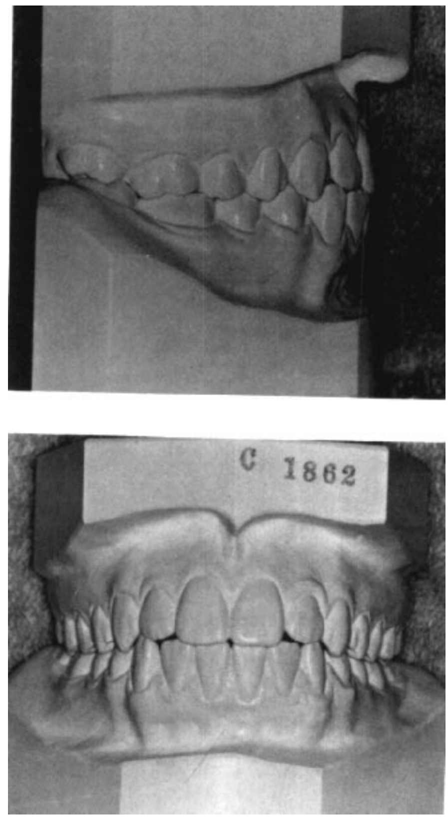

Fig. 23 Posttreatment models of case K.L.

the fact that so many cases show overbite relapse, so why not make yourself feel better by finding a reason for liking overbite.

Gnathologically speaking, when incisal guidance is lacking, the patient is in no trouble if there is anterior guidance. In protrusion the guidance can come from the canines or even first premolars just so the molars are not in prolonged contact. Witness all the untreated dental openbite cases with perfectly healthy temporomandibular joints.

Dental Openbite

In a normal skeletal pattern the most probable cause of dental openbite is environmental, a sucking habit or tongue-thrust swallow. Obviously if treatment is to be successful the etiological factor must be eliminated.

The most pernicious and difficult of all environmental factors to control is the tongue-thrust swallow. It is not within the scope of this paper to discuss the virtual impossibility of successfully eliminating such a swallow with myofunctional therapy.

A very positive solution to the tongue-thrust problem is to place lingual tongue spurs on the lower incisor bands and then on the retainer to keep the tongue under the subliminal influence of the spurs. The technique has been detailed elsewhere.[7,8]

Brodie described the use of tongue spurs in 1939.[7] In lectures to students, he spoke of Angle using spurs to correct lip sucking and tongue habits.

The photographs in Figure 24 are of an 18 year-old female taken one year apart. Note the extraordinary correction in anterior openbite resulting from the elimination of the tongue thrust, as tongue spurs are in place on the lower incisor bands. There was also marked intrusion of upper and lower buccal teeth by action of a vertical-pull chin cup. Figure 25 shows very definite intrusion of the first molars.

It would seem that this case will have an excellent prognosis for stability of the dental openbite correction. Unquestionably it must be more favorable than if vertical elastics were employed in treatment.

Summary

Four possibilities for correction exist regarding the vertical dimension. They are correction of skeletal and dental deepbite and skeletal and dental openbite. A growth-oriented approach to each problem was presented in this review.

To treat skeletal deepbite it is nec-

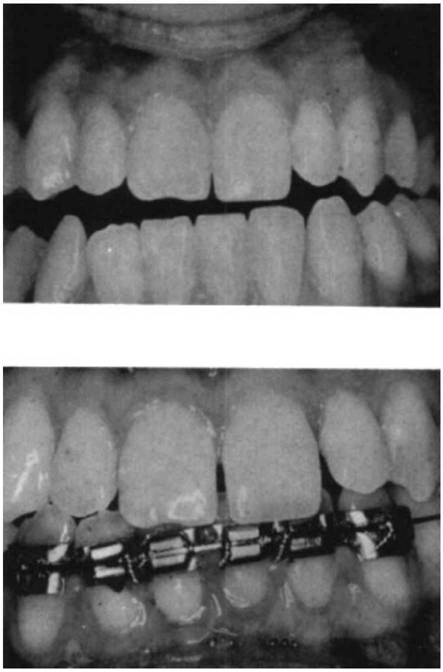

Fig. 24 Frontal intraoral photographs demonstrating significant correction of the anterior openbite in a young adult without benefit of vertical elastics.

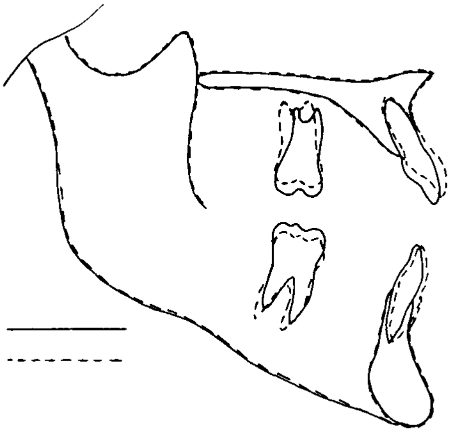

Fig. 25 Superimposed separate tracings of the maxilla and mandible of the patient demonstrated in Fig. 24. Consider the marked intrusion of the molars in one year's time. Solid lines original tracing, dashed, one year later.

essary to cause the jaws to be separated by torquing the maxilla in a counterclockwise manner at the posterior end and to additionally stimulate posterior alveolar development. Rapid palatal expansion to loosen the maxilla and then torquing the maxilla with a heavy Class III diagonally directed force is effective toward this end.

Dental deepbite is correctable and uncommonly stable when incisor eruption is prevented in the growing child or when incisors are intruded in the adult. Mechanics utilizing leverage were presented to fulfill these objectives.

The most biological approach to closing the skeletal openbite pattern would be to depress posterior tooth segments in the adult. In a growing patient many more possibilities exist, the posterior tooth eruption can be impaired which leads to diminished posterior alveolar growth, or the normal descent of the maxilla can be prevented; finally mandibular growth can be redirected into a more horizontal plane. All these objectives can be admirably accomplished with force supplied by a vertical-pull chin cup.

Dental openbite is almost always caused by errant environmental factors and as such the most natural treatment would be to eliminate the cause be it habit or pattern. The habits are readily correctable, patterns are not. The most serious environmental pattern affecting dental openbite is the tongue-thrust swallow. Lower lingual tongue spurs encourage a normal swallowing physiology without any possibility of the punitive aspects the uninitiated assign to their use.

While Allan G. Brodie might not recognize some of the mechanics presented here he would easily comprehend them as the philosophy prompting them is entirely his.

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