Control of Anterior Vertical Dimension and Proper Selection of Extraoral Anchorage

ROBERT J. KUHN, D.D.S., M.S.D.

The relative merits of mandibular rotation (opening versus closure) should be recognized as either a desirable or undesirable effect of orthodontic treatment as it relates to the individual. The control of posterior tooth eruption is the most managcable factor available to the orthodontist in the overall control of anterior vertical dimension of the lower face.

Individuals vary in ability to resist posterior tooth eruption during orthodontic treatment. Extraoral anchorage as well as other mechanical procedures are capable of changing the anterior vertical dimension of the lower face markedly during the resolution of an orthodontic problem by influencing the vertical relationship of the posterior teeth. Attention has previously been drawn to the effect of vertical changes in the molar area.[1]

In an evaluation of the extrusion of the posterior teeth resulting from the use of conventional appliances, this paper will be directed to the following areas:

1. An appraisal of diagnostic factors contributing to mandibular opening.
2. Considerations which make mandibular opening undesirable.
3. An evaluation of some orthodontic mechanics and their application to particular cases with the objective of controlling mandibular rotation.
4. A review of the forces associated with various headgears to facilitate individual selection.

Read before the Southern California Component of the Angle Society, June 1967.

Diagnostic Factors Contributing To Or Consistent With Mandibular Opening

Most of these factors contribute to open bites. Several, it should be recognized, are hypothetical but frequently found in association.

1. Skeletal Openbite Pattern[2] (Figure 1). The presence of some of the skeletal characteristics, as depicted by the patient in Figure 1, may alert the clinician to the susceptibility of that particular patient to bite opening.
2. Congested airway. May be due to congested nasal passages, a congested naso and/or oral pharynx resulting from allergies, tonsil and adenoid obstruction, a basic anatomic insufficiency, or a combination thereof.
3. Tongue thrust and/or detrimental tongue posture.
4. Occlusal disharmonies. Grouped as follows:

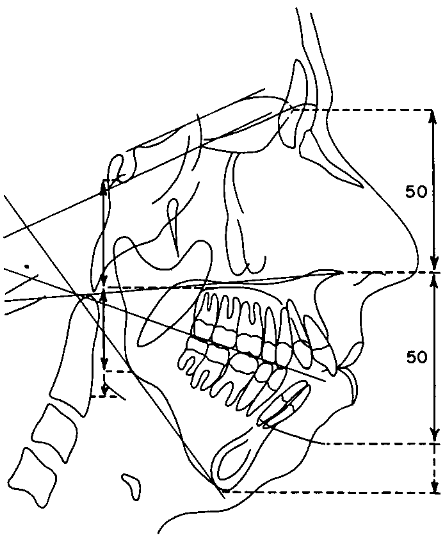

Fig. 1

Downloaded from http://meridian.allenpress.com/angle-orthodontist/article-pdf/38/4/340/1368385/0003-3219(1968)038_0340_coavda_2_0_co_2.pdf by guest on 07 February 2025

a) Prematurities disallowing maximum occlusal contact.
b) Atypical occlusal anatomy.
c) Heavily restored or crowned teeth which are poor anatomical reproductions.
d) Pulpal hyperemia due to trauma, decay, etc.

5. Flat occlusal anatomy.

6. Temporomandibular joint disturbances.

7. Pain threshold and proprioceptive tolerance of the individual.[3]

8. Total masticatory musculature. Because of the relative importance attached to this musculature, further comment and clarification are indicated.

Attention is drawn to the similarity that exists between the muscles of mastication and an appliance such as the Milwaukee brace. Both act on the teeth through the supporting alveolar bone. The bite-closing capabilities of the Milwaukee brace have been conclusively substantiated.[4] The vertical dimension of the lower face is quite susceptible to change while the brace is worn. The effect that the muscles of mastication may exert on lower facial dimension by virtue of their constancy of action, anatomic placement and variability of contraction should be a consideration.

Orthodontists have perhaps subconsciously attempted to read muscle force into a head film. There is some correlation between the square-jawed, low mandibular plane cases and strong muscle contraction.[5] Likewise, there is a relationship between the high mandibular plane pattern and weak muscle function. But it is not an absolute correlation as evidenced by the varying muscle contractions associated with the various types of faces. For example, a high plane (divergent) case may, by virtue of strong masticatory muscle and its favorable anatomic placement over the molar area, be quite capable of resisting vertical dimension increase in the lower face from orthodontic forces. Conversely, the low plane case may open quite easily.

A technique that has been used for those patients who do not demonstrate a strong muscle contraction, felt by palpation over the masseter and temporalis areas, is to place them on isometric exercises. Cut pieces of rubber tubing are closed on vigorously between the upper and lower posterior teeth in order to increase that particular patient's masticatory muscle strength.

Considerations for Determining the Desirability of Mandibular Opening

1. Facial esthetics. There are several facets of facial esthetics that merit attention in a consideration of bite opening or closure.

a) Lip length. Is there an inadequacy or a redundancy? If short lips are present and closure is strained, nothing should be introduced in the treatment mechanics to increase lower facial height. Conversely, in the individuals with excessive lip length, bite-opening procedures may be desirable.
b) Mentalis. Mentalis action associated with lip closure is sometimes considered to be synonymous with bimaxillary protrusion. However, it may be primarily associated with a lip-length inadequacy. In that instance, no amount of dental retraction will gain adequate lip-length for complete mentalis relaxation.
c) Total facial esthetic balance. This refers to the relationship of upper to lower face. It has been demonstrated that a face is esthetically harmonious when a ratio of upper to lower face (measured supraorbitale to ANS and ANS to gnathion [Fig. 1]) is generally of

Downloaded from http://meridian.allenpress.com/angle-orthodontist/article-pdf/38/4/340/1368385/0003-3219(1968)038_0340_coavda_2_0_co_2.pdf by guest on 07 February 2025

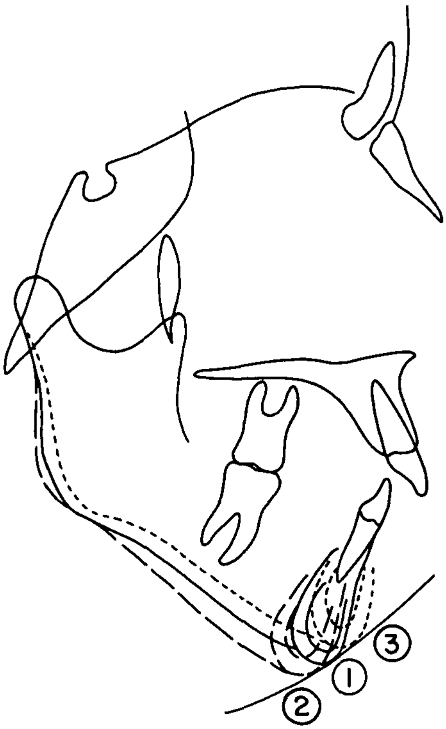

Fig. 2

Fig. 3

equal proportions.[6] Should this relationship be weighted to the lower face at the outset of treatment, further bite-opening will only work a detriment to the facial balance. The skeletal landmarks should serve as a starting point. Final determination of facial esthetics is still dependent on the adequacy or inadequacy of the integument of the lower face.

Figure 2 is an illustration of the various hinging positions of the mandible as an expression of eruption or depression of posterior teeth. Several millimeters of posterior tooth eruption or depression are magnified at pogonion to elicit the changes to the chin point that are illustrated. One millimeter of vertical movement of the molars results in approximately three millimeters of rotation of the mandible as measured at gnathion.

Equally important are the changes in the soft tissues of the lower face. Figures 3, 4 and 5 depict the soft tissue changes that occur in the lower face relating to the movements of the mandible as seen in Figure 2. Figure 3 is the number one or neutral position. In Figure 4 the mentalis action has increased (corresponds to the number 2 position of the mandible) and the lips stretched thinner as the patient attempted lip closure. There is a marked difference in facial esthetics between the patient in Figure 4 and the same patient shown in Figure 5 which illustrates the bite closed position of the mandible. Note the relaxed lips and chin and the overall effect of facial esthetic harmony.

2. Dental esthetics (uncomplimentary anterior tooth to lip relationships). There are other causes for this phenomenon, but it is discussed here as it relates to posterior tooth eruption. The more the posterior teeth are erupted, the more the anterior teeth (in the absence of a deep overbite) need be

Downloaded from http://meridian.allenpress.com/angle-orthodontist/article-pdf/38/4/340/1368385/0003-3219(1968)038_0340_coavda_2_0_co_2.pdf by guest on 07 February 2025

Fig. 4

Fig. 5

extruded. This occurrence in the individual with a long lower face and/or in the individual with inadequate lip length results in the excessive display of maxillary gingival tissue when the lips are parted in talking, smiling, etc.

3. The horizontal expression of mandibular growth. It has been noted previously how a slight change in vertical movement of the posterior teeth can markedly affect the chin point. In the Class II rapidly growing individual, this phenomenon is a prime consideration. By neutralizing the extrusive element to the posterior teeth while they are being held or moved distally, maximum utilization may be made of the horizontal growth component of the mandible. The net result is a relatively rapid correction of the Class II relationship.

It would be appropriate next to evaluate some of the mechanics utilized to resolve an orthodontic problem and how their application to a particular patient may affect mandibular rotation. Mandibular opening may be initiated in some instances with the placement of separation. Not only can there be an actual opening produced by the thickness of the separators, but also a possible lessening of masticatory muscle function due to the soreness of teeth. Beyond this, what are some of the major mechanical considerations in treatment which actually elicit an undesirable mandibular opening in a susceptible individual?

Evaluation of the Forces of Some Common Mechanical Procedures

1. A cervical gear to the maxillary molars (Figure 6). There is a considerable force component in the vertical direction which will erupt teeth.

2. Class II or Class III elastics. Depending on which is used, the result is a vertical or eruptive force to mandibular or maxillary molar teeth.

Downloaded from http://meridian.allenpress.com/angle-orthodontist/article-pdf/38/4/340/1368385/0003-3219(1968)038_0340_coavda_2_0_co_2.pdf by guest on 07 February 2025

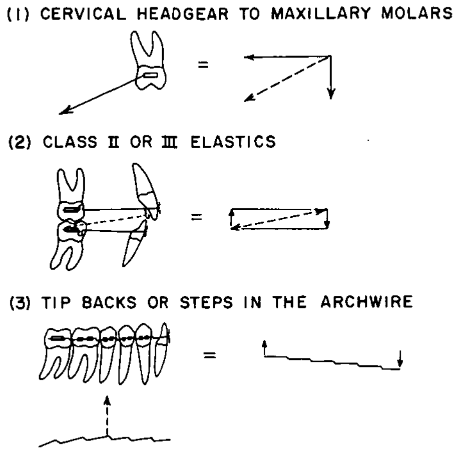

Fig. 6

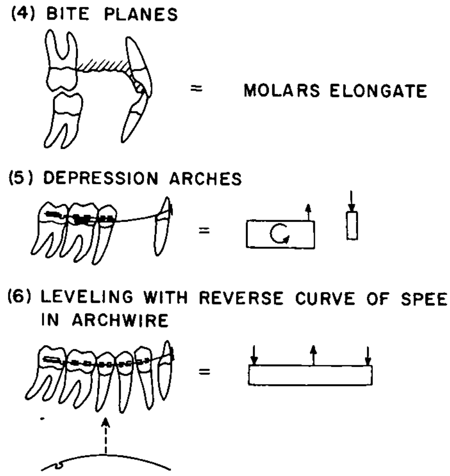

Fig. 7

3. Second order or tip back bends. There is a net force which erupts posterior teeth while the opposite force is a depressing one on the incisors. As the diagram illustrates, these steps will cause posterior teeth to erupt and anterior teeth to depress.

4. A bite plane (Figure 7). Either with vertical elastics or in the absence of them, it will encourage vertical molar eruption with resultant opening of the bite.

5. A segmented approach to eliminate overbite, the depression arch. Note the forces of eruption in the bicuspid area—a bite opening force. The eruption of the bicuspid area would be maximal if heavy forces are used to intrude the anterior teeth. It is known that low force values intrude anterior teeth optimally and would cause a minimal eruption in the bicuspid area.

6. Reverse curve of spee in a continuous archwire. This is another approach to overbite correction and gives as a net effect eruption in the bicuspid area with bite opening.

There are other specifics of treatment which transmit an eruptive force to buccal teeth and thus cause an opening of the bite. These would vary somewhat depending on the appliance used.

The Effects of Varying Applications of Appliances

1. Daily rate of appliance and auxiliary wear. There is considerable variation concerning this observation and to be meaningful needs to be related to the individual. There seems to be a maximum time level from which a specific dentition can recover from an extrusive movement of the posterior teeth. Consistent with the variation, the maximum may theoretically vary from 0 to 24 hours per day. Considering this maximum time as it pertains to the individual it may be generally stated that: the greater the time an extrusive mechanical movement is placed on the posterior teeth, the less probable these teeth can resist total net eruption. The masticatory musculature is one of the dominant considerations in this regard.

2. The number of teeth under positive control. To clarify, reference is made to the vertical resistance of groups of teeth rigidly held together as opposed to single tooth units. Using the cervical gear as an example, the recovery of posterior tooth eruption by the muscles of mastication apparently occurs more readily if this gear is worn to molars only versus like time delivered to segments or arches of teeth.

Downloaded from http://meridian.allenpress.com/angle-orthodontist/article-pdf/38/4/340/1368385/0003-3219(1968)038_0340_coavda_2_0_co_2.pdf by guest on 07 February 2025

Having completed some preliminary considerations, without which the use of a particular headgear would be somewhat meaningless, it is now possible to proceed to the final determination of headgear type. The employment of a particular headgear is dependent only on the needs of the orthodontic case and the imagination and mechanical skill of the orthodontist. Theoretically, any direction of pull is possible. However, only those types which are in more common usage today will be examined in detail.

The headgear and the various directions of pull possible should be considered as a part of the total force system in effect on any given orthodontic case. It may be designed to effect movement of teeth or it may be primarily a stabilizing device to eliminate or cancel a force which tends to displace teeth disadvantageously. The more common types of headgears are illustrated in Figure 8.

1. High occipital headgear to the incisal area of the archwire.
2. Cervical gear to a face bow.
3. High cervical (low pull) headgear to a face bow.
4. Occipital headgear to a face bow.
5. High occipital headgear to a face bow.
6. Cervical to a face bow on the mandibular arch.

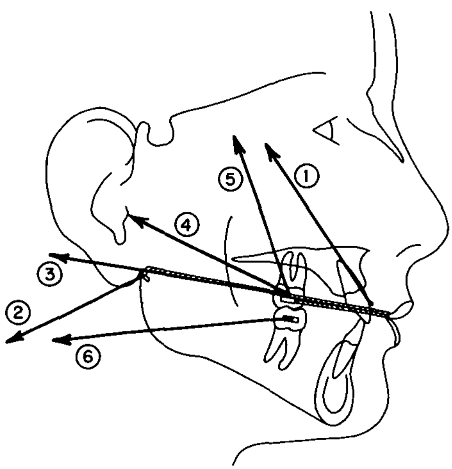

Fig. 8

The Linear Force Vectors and Moments Delivered by Various Headgears

High occipital headgear directed to the incisal area

Specific reference is made to:

a) The depressing effect to the maxillary incisors. This will either give incisal depression or serve to resist eruption of the incisors during Class II elastic wear. By comparison to the depressive component, there is not a large vector of force distally.

b) The moment on the incisors (a lingual root torque) as well as a rotational effect to the maxilla since both incisors and molars are rigidly connected by an archwire.

Cervical gear to a face bow connected to the maxillary molars

There are various possibilities:

a) The outer bow level or below the level of the inner bow; note the direction of the components of force in a distal and in an eruptive direction. In addition, there is a moment present which will rotate the crowns of the molars distally.

b) The outer bow high to effect distal bodily movement. Note the comparatively high vector of eruptive force plus the moment which tends to move the roots distally.

c) With the addition of an incisal spur to give greater eruption to the molars, we get depression of the incisors and a net result of occlusal plane tipping or rotation of the maxilla.

High cervical (low pull) headgear

Delivered through a face bow to the molar area, it is designed to move teeth

Downloaded from http://meridian.allenpress.com/angle-orthodontist/article-pdf/38/4/340/1368385/0003-3219(1968)038_0340_coavda_2_0_co_2.pdf by guest on 07 February 2025

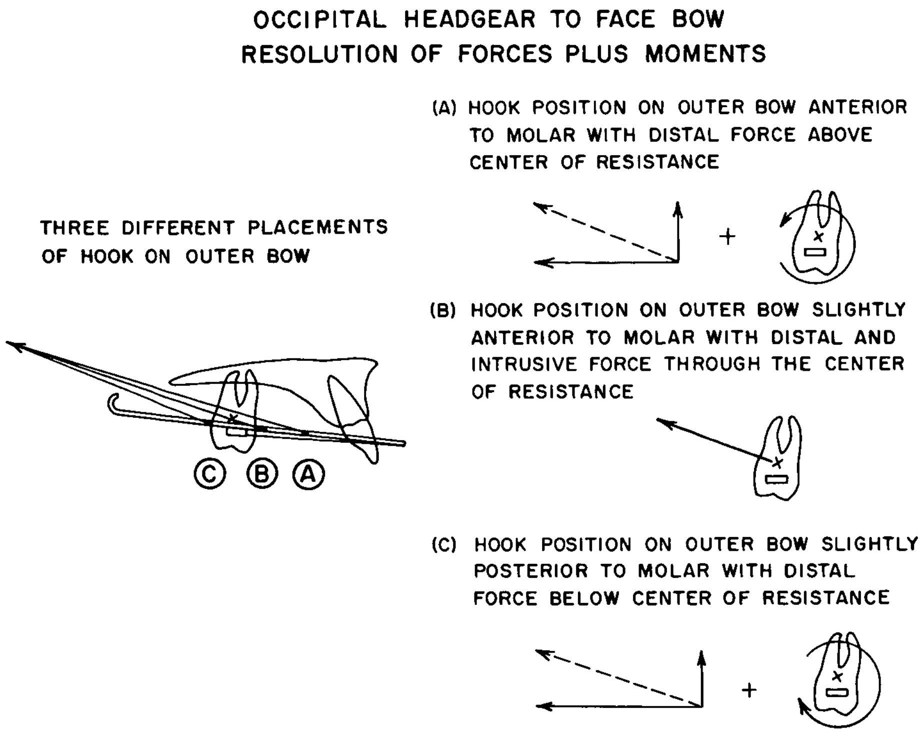

Fig. 9

distally with very slight intrusive or extrusive vectors present depending on the position of the outer bow.

a) With the outer bow slightly above the level of occlusal plane, the result is a force through the center of resistance and distal bodily movement.

b) If the outer bow is low, there is an intrusive force as well as a distal force and a moment which will tip the crown distally.

Occipital headgear

Delivered through a face bow to the molar area, this headgear will give a distal and slightly intrusive force to the maxillary posterior teeth (Fig. 9). It is designed to move molar teeth upward and backward or, at worst, keep the posterior teeth from erupting. Note the horizontal and vertical components of force. It is interesting by way of comparison to see that this headgear is capable of delivering just as great, and in some cases a greater, distal force to the molar than the cervical gear. Yet it does not deliver the sometimes undesirable extrusive vector. As indicated by the diagram, it is quite important to place the hook on the outer bow correctly in order to accomplish the desired root or crown tipping, or bodily movement. Because it is so important to position the force correctly on the outer bow depending on what type of tooth movement is desired, it is preferable to solder a hook on the outer bow. This then leaves the outer bow intact and allows for a change in force action by merely changing the hook position. Figure 9 illustrates the three more common placements of the hook on the outer bow when the occipital headgear is used.

a) The hook is positioned on the outer

Downloaded from http://meridian.allenpress.com/angle-orthodontist/article-pdf/38/4/340/1368385/0003-3219(1968)038_0340_coavda_2_0_co_2.pdf by guest on 07 February 2025

bow anterior to the molar with the distal force above the center of resistance of the maxillary molar. This results in a distal and intrusive force plus a moment to move roots distally.

b) The hook position is closer to being opposite the molar tube (slightly anterior). The force direction in this case is upward and backward through the center of resistance of the molar and results in translation or bodily movement of the tooth.

c) Indicates the forces at work if the hook is located distal to the molar tube on the outer bow. There is a distal and an intrusive force but in addition there is a moment to move the crown distally.

High occipital headgear.

Delivered through a face bow to the maxillary molars. A large component of intrusive force is possible with this type of headgear. As in the occipital headgear, care is needed to place the hook on the outer bow correctly to obtain distal crown or root tipping or upward and backward bodily movement. The more vertical the pull relative to occlusal plane, the greater the tendency for the molars to roll out to the buccal. Therefore, a lingual arch is often indicated with this headgear to prevent molar crowns from "rolling out" to the buccal. This is necessary because of the off-center intrusive force which produces this "roll out" effect. Note at number one in Figure 8 how the maxillary molar behaves to this depressive type force. There is a moment which rotates the molar to the buccal.

An interesting phenomenon may occur with this arrangement which is designed to depress posterior teeth and close bites. In the absence of the lingual arch (A in Figure 10) the maxillary molar rolls out to the buccal and the lingual cusp makes premature contact with the inclined planes of the buccal cusps of the mandibular molar. The net effect is an actual opening of the bite. Observe B in Figure 10 with the lingual arch in position. The moments cancel, the net result being a pure depressive force to the molar.

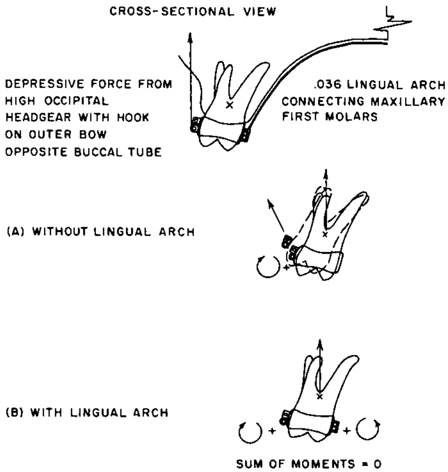

Fig. 10

Figure 11 compares the relative horizontal and vertical force components of four of the previously discussed headgears. It is interesting to note the relative distal forces of the occipital and the cervical headgears.

Cervical gear to the mandibular molar area

Delivered through a face bow, this headgear is used on the maximum anchorage cases where no increase in vertical dimension can be tolerated and where, if possible, some depression would be desirable (Fig. 12).

There are three basic possibilities depending on outer bow placement:

a) The outer bow level with the occlusal plane. There is an intrusive force, a distal force, and a strong moment to rotate the molar crowns distally.

b) Lower outer bow position than (a). Results in a net translatory or bodily force through the center of resistance of the molar.

Downloaded from http://meridian.allenpress.com/angle-orthodontist/article-pdf/38/4/340/1368385/0003-3219(1968)038_0340_coavda_2_0_co_2.pdf by guest on 07 February 2025

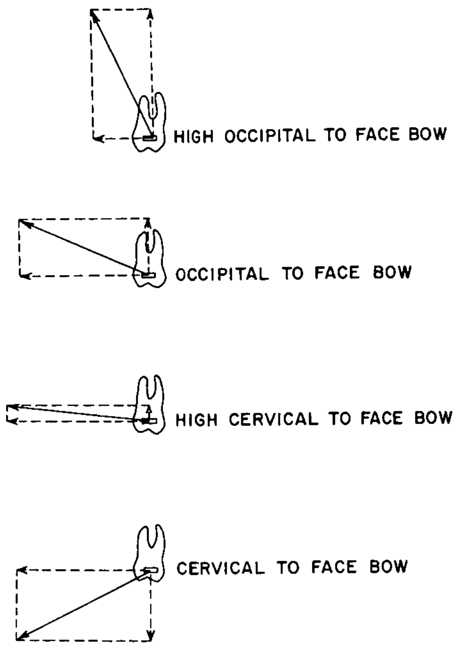

Fig. 11

c) Lower outer bow position. This arrangement delivers a distal force and either a slight intrusive force or a slight extrusive force depending on how low the outer bow is adjusted. In addition, there is a strong moment to rotate the roots of the molars distally.

It may be necessary to place a lower lingual arch depending on the amount of intrusive force delivered to the molar.

Summary

With mandibular opening as a recognized problem, an attempt has been made to outline an approach to headgear selection as a part of orthodontic treatment. This must include a thorough pretreatment examination which evaluates the following diagnostic factors:

1. Skeletal pattern
2. Airway

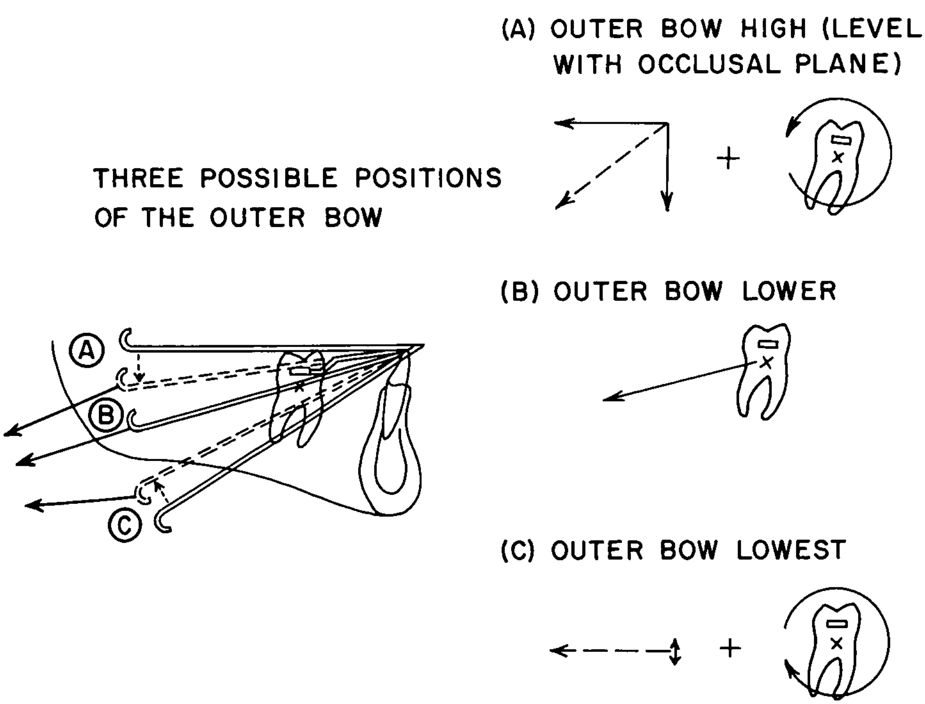

Fig. 12

Downloaded from http://meridian.allenpress.com/angle-orthodontist/article-pdf/38/4/340/1368385/0003-3219(1968)038_0340_coavda_2_0_co_2.pdf by guest on 07 February 2025

3. Tongue action and position
4. Occlusal disharmonies
5. Occlusal anatomy
6. Temporomandibular joint disturbances
7. Pain threshold and proprioceptive tolerance.
8. Masticatory musculature.

This forms a baseline. To these factors must be added the possible detrimental effects of mandibular opening on facial esthetics, dental esthetics, and effective mandibular growth. An evaluation of the mechanical approach to treatment follows. Consideration is also given to the varying effects produceable by various applications of certain appliances and auxiliaries. By considering all of these factors the correct headgear can be coordinated with the total force system so that it will blend harmoniously with and complement the other treatment mechanics.

Conclusions

1. There is a complexity of factors responsible for mandibular opening.
2. Posterior tooth eruption is the principal controllable factor which affects anterior vertical dimension of the lower face.
3. The variation of the individual is stressed.
4. Further consideration and study of the muscles of mastication are indicated in order to assess more accurately their clinical significance and possible relationship to lower facial development.
5. Facial and dental esthetics and the effective horizontal expression of mandibular growth should be important considerations influencing the treatment approach.
6. An awareness of the mechanics necessary to resolve an orthodontic problem and their possible effects on mandibular opening is indicated.
7. The effect on mandibular opening of the daily rate of appliance and auxiliary wear and the number of teeth positively controlled need further consideration and study.
8. An understanding of the various linear forces and moments produced by each headgear is essential to its optimum use in the total mechanical approach to a given orthodontic problem.

15 East Arrellaga
Santa Barbara, Calif. 93101

Acknowledgment

I wish to express my thanks to Drs. Robbie Robinson, Jack Rathbone, Robert Ricketts, and Charles Burstone for their encouragement and help in the preparation of this manuscript.

References

1. Schudy, F. F.: The Rotation of the Mandible Resulting from Growth: It's Implications in Orthodontic Treatment. *Angle Ortho.*, 35:36, 1965.
2. Sassouni, V., and Nanda, S.: Analysis of Dentofacial Vertical Proportions. *Amer. J. Ortho.*, 50:801, 1964.
3. Ricketts, R. M.: Personal Communication.
4. Alexander, R. G.: The Effects on Tooth Position and Maxillofacial Vertical Growth During Treatment of Scoliosis with the Milwaukee Brace. *Amer. J. Ortho.*, 52:161, 1966.
5. Moller, E.: The Chewing Apparatus. *Acta Physiologica Scandinavica.* Vol. 69, Supplementum 280, 1966.
6. Sassouni, V.: The Face in Five Dimensions, Morgantown, W. Va., *West Virginia University Press*, 1962.
7. Burstone, C. J.: Personal Communication.

Downloaded from http://meridian.allenpress.com/angle-orthodontist/article-pdf/38/4/340/1368385/0003-3219(1968)038_0340_coavda_2_0_co_2.pdf by guest on 07 February 2025