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DENTOFACIAL ORTHOPEDICS VERSUS ORTHODONTICS*

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Heavy, interrupted extraoral force against bone may be used successfully to correct abnormal anteroposterior and vertical jaw relationships. High-pull headcaps and chincaps, with elastic traction against an occipital base were used for mandibular prognathism (Class III) and open bite cases. Spring-loaded cervical tubes were used in maxillary protraction and mandibular retrusion (Class II, Division I) problems. Three to 4 pounds pressure were used against each jaw in this study. This magnitude of force is considerably greater than that used for tooth movement and similar to the amount of force used in the correction of spinal and long-bone deformities in orthopedics. Results indicate that treatment is most successful when appliances are worn 2 to 4 years, preferably during times of greatest growth.



Fig. 1 ■ Royal hereditary prognathism. Charles IV married his cousin, Maria Louisa of Parma. She and four out of five of her children had mandibular prognathism.

The orthodontist may learn technics from the orthopedic surgeon. For years orthodontics has been called dentofacial orthopedics in Europe. Despite the questionable success in achieving consistent results in orthodontics with orthopedics, using removable appliances, the orthopedic concept is useful.

Most patients treated by orthodontists in the United States have problems involving abnormal anteroposterior jaw relationships in which mandibular prognathism or retrusion are dominant characteristics. Long before people were concerned about straightening teeth, they were aware of some of the more unsightly facial characteristics associated with malocclusion. For many years, the "Hapsburg Jaw" was well known and was displayed on coins and pictures throughout Europe; an example of this hereditary mandibular prognathism is seen in the painting of Charles IV of Spain and his wife, Maria Luisa of Parma, who was his cousin.[1] The painting shows five of their seven children (Fig. 1). Charles has a prominent proboscis, whereas his wife and four of these five children have a mandibular prognathism.

Textbooks by Farrar,[2] Kingsley,[3] and Angle[4] show the use of chincaps to correct maxillomandibular malrelationship. This technic is not the first use of pressure to change head shapes. The Peruvians bound skulls of their infants between boards and created pronounced craniofacial deformities. Another example of

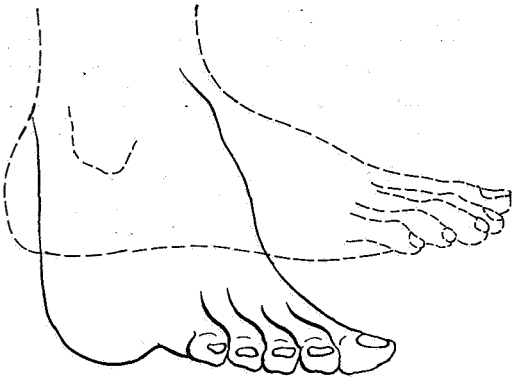


Fig. 2 ■ Binding of feet of Chinese women to length of 4.0 inches (solid line) redirected growth vertically.

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the restrictive influence of environmental forces on developing bone is the former tradition of binding the feet of Chinese women to restrict their length to 4.0 inches. Whereas the feet were greatly shortened by the external pressure, most of the growth was redirected into a greatly increased vertical height of the foot. (Fig. 2).

With the advent of so-called Baker anchorage or intermaxillary elastics, extraoral appliances were mostly discarded. In 1930 Oppenheim[5] used extraoral force to treat maxillary protrusions and Class II, Division I malocclusions. Other clinicians, by use of extraoral force in conjunction with fixed and removable orthodontic appliances, attempted to effect an occlusal change. Even the chincap has been brought back into use in some instances in Europe, although its use in the United States has been limited. Thompson and others[6] have criticized the use of such appliances, claiming that it is possible to create functional retrusion and that it will cause temporomandibular joint disturbances.

Extraoral appliances in current use, whether they are cervical straps, low-pull, medium-pull, or high-pull headgears, apply the same range of force. A patient usually wears an extraoral appliance when he sleeps. The orthodontist attempts to have the patient wear the appliance 10 to 12 hours per day, to provide sufficient force to move the teeth distally or to retard maxillary growth. The magnitude of force is generally between six and twelve ounces per side with present extraoral force usage. As recommended by Kloehn, the force is almost always directed against the first molars through a combination outer and inner bow arrangement (Fig. 3), with the internal arch stopped at the molars and standing away from the maxillary incisor teeth. Thus, the extraoral appliance is activated by forces similar to those incorporated in routine fixed appliance adjustments — a range of force that is primarily designed to move teeth. There is a very real place for the use of extraoral force in this category, over and above the orthopedic, heavy force application, discussed later in this article.

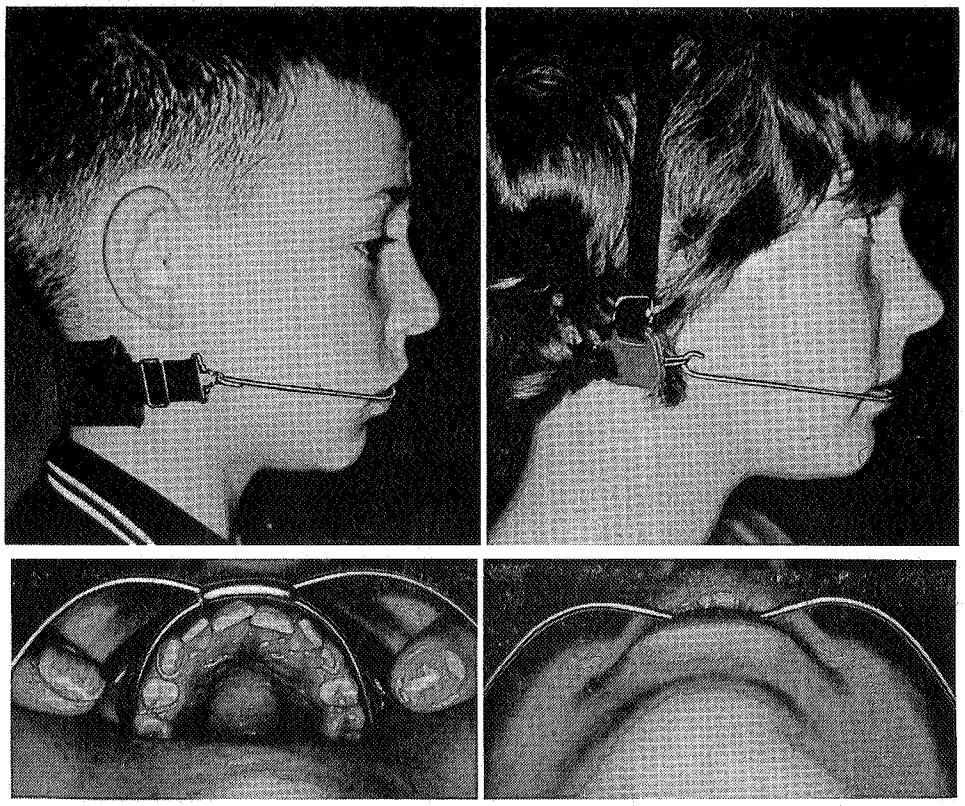


Fig. 3 ■ Extraoral appliances used in conjunction with conventional tooth-bearing orthodontic appliances. Force is in range of tooth-moving demands and is supplied by elastic traction. Inner bow usually inserts into round buccal tube. Moving molars distally, bolstering anchorage, and offsetting Class III mechanics are some objectives of technic.

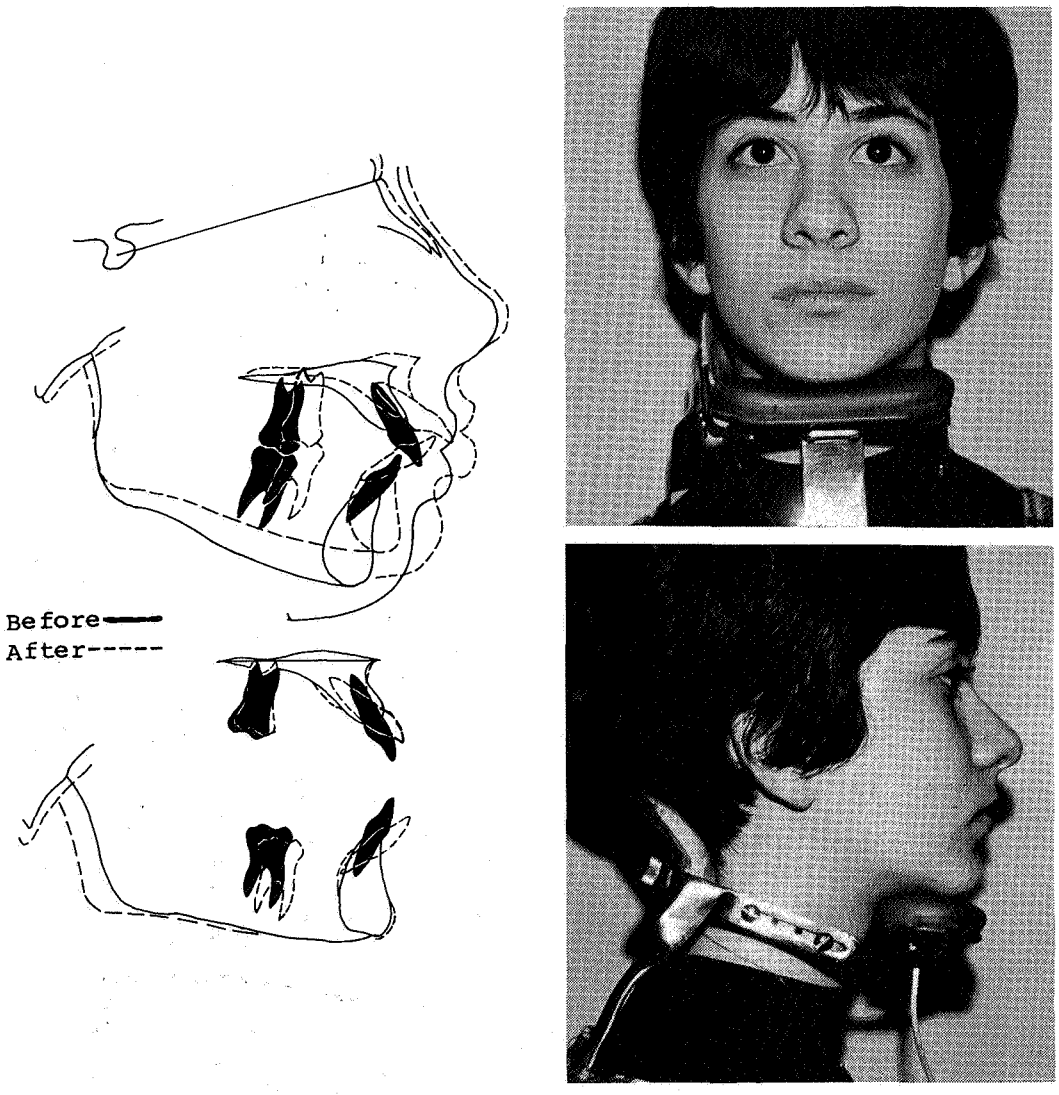


Fig. 4 ■ Tracing from Alexander (left) shows deformation created on basal mandibular structure and tooth-bearing area by prolonged wear of Milwaukee orthopedic brace (right) that is used to correct scoliosis. By exerting constant lengthening pressure on vertebral column, brace gradually reduces curvature. Opposite effect occurs in dentofacial region.

Despite the complete rejection of the use of extraoral force by the well-known Begg[7] philosophy, considerable success has been achieved by extraoral force. When patients co-operate, proper application of extraoral force during the growth period of the patient yields good results.

Two thirds of the average orthodontist's practice consists of problems that are maxillo-mandibular malrelationships; there is a basal anteroposterior abnormality with the teeth largely reflecting the jaw relationship. Local muscle factors create additional aberrations, and functional forces accentuate the inherent deformity by homeostatic activity, but the basic problem is the anteroposterior bony malrelationship. The problem may be Class II, Division 1; Class II, Division II, or Class III malocclusion, but occlusion is poor because the jaws are not related properly.

At the beginning of the twentieth century, it was hoped that intermaxillary elastics would stimulate mandibular growth.[4] Orthodontists continue to hope that conventional tooth-moving appliances will stimulate mandibular growth and

cause the needed facial changes. The Oliver guide plane and the various removable appliances such as the monobloc are not routinely effective; problems of creating the desired facial profile changes still exist.

Disciples of the Tweed and Begg technic claim that significant facial changes may be produced routinely with these multibanded intraoral technics.[8] Begg, refusing to use extraoral force, is not concerned about growth and development. Nevertheless, the average orthodontist has difficulty in routinely producing the significant changes shown in studies that describe the conventional fixed-banding technics

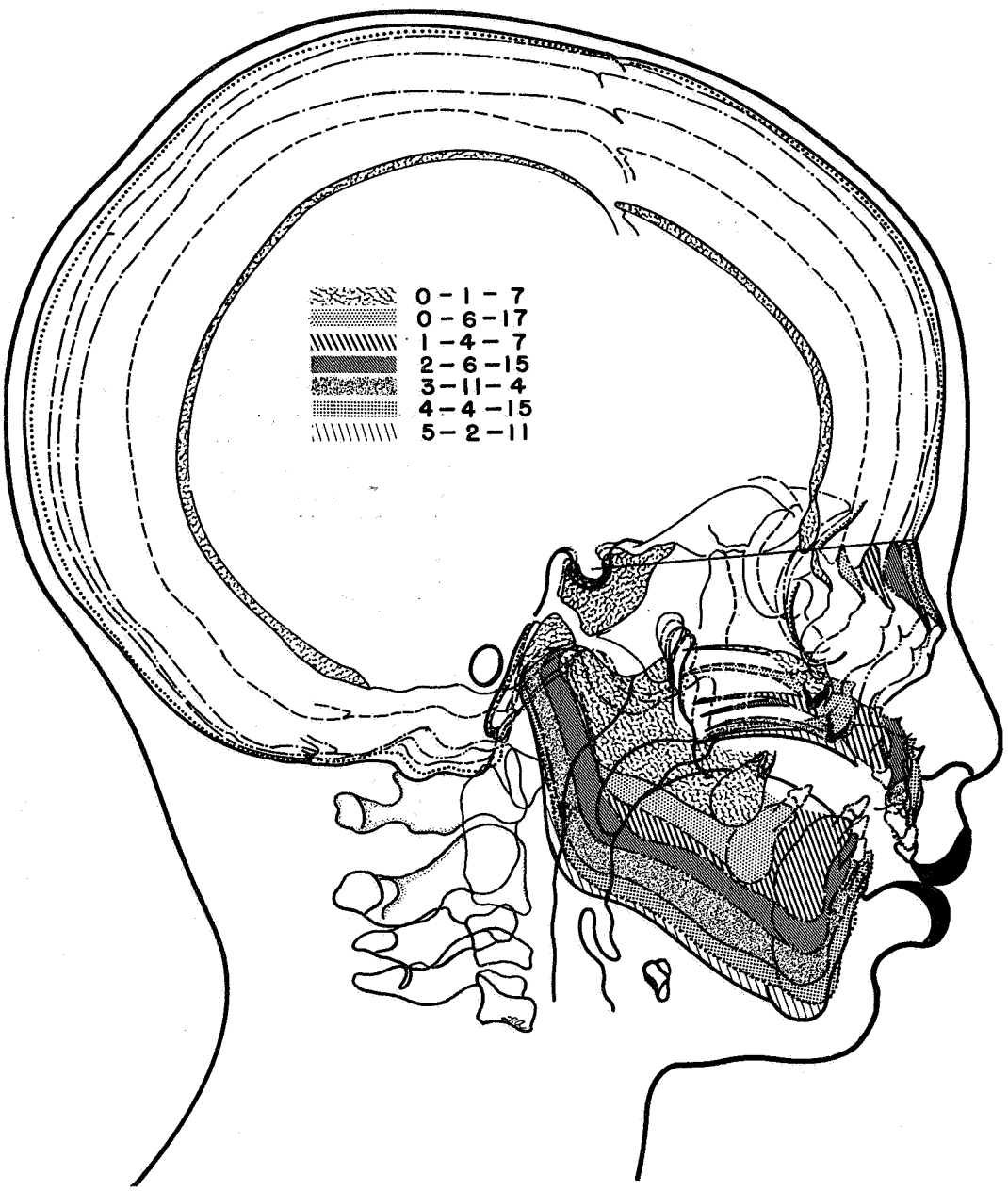


Fig. 5 ■ Serial cephalometric tracings show downward and forward facial growth in patient from age 1 month, 7 days, to 5 years, 2 months, 11 days. Mandible emerges from beneath cranium and lower face height is increased. In normal craniofacial development, pattern of growth is essentially similar through puberty. Note that growth is more horizontal or vertical at different periods.

of any so-called system. In most patients, there is a jaw malrelationship that produces the dental malocclusion because of the anteroposterior spatial abnormality.

When there is an abnormal skeletal bony relationship, as in scoliosis, the orthopedic surgeon recognises that bone responds to pressure when it is growing. He places a splint which, in effect, straightens the bony members and restores a normal relationship. A number of men have recently called attention to the undesirable side effects of these metal guiding splints in the process of guiding spinal growth and development. Pressures are exerted by the Milwaukee brace on the mandible. Figure 4 shows what happens when these pressures are applied to the growing mandible.[9, 10]

Despite the validity of the concept and the common use of extraoral force against the maxillary arch to attempt the necessary changes, the long-term success has been sporadic. To be effective, these external forces must be active for a minimum of 10 hours and preferably for as much as 14 hours per day. The patient who wears a Milwaukee brace to correct spinal deformities usually wears the brace eighteen to twenty-two hours per day. Of prime importance to the orthopedic surgeon, as well as to the orthodontist, is the magnitude or intensity of force. The amount of force produced by the Milwaukee brace against the mandible ranges from five to ten pounds. This is in marked contrast to the average headgear, which exerts tooth moving force of six to twelve ounces per side with latex elastics.

If these heavy orthopedic forces could be used by the orthodontist, he should be able to produce similar orthopedic-like results in the craniofacial region. Despite the admonitions by the dentist concerned with the temporomandibular joint problems and the possible creation of adverse sensory responses, with the possibility of pain and soreness, we have applied these heavy Milwaukee brace-like forces to a number of patients over the past eighteen years to determine the effects, both good and bad. The magnitude of force used is three to four pounds of pressure routinely against the mandibular basal bone itself, with the force transmitted through the symphysis. But in the maxilla, however, we most frequently use only one to two pounds, since the force is directed against the maxillary teeth directly, and indirectly against the maxillary basal bone itself.

An important aspect of force application is the interrupted force principle. Force is directed for ten to fourteen hours per day, with the balance of time a rest period to prevent damage, root resorption, etc. and to allow tissue recovery. Although such damage is less likely when the magnitude of force is beyond tooth moving range, the possibility would exist with continuous force application and no rest period. As Reitan has shown, once the protective barrier of the tooth is breached by resorptive processes, the pathologic response will continue for some time even after all force has been removed. Reitan has shown in his latest research that force beyond one pound exceeds the tooth-moving threshold and variations in magnitude are less critical. In the results reported in the present study, one to two pounds pressure, against the teeth in the maxilla with intra-oral appliances on the teeth receiving the force, has proven quite adequate. Force of a higher order may produce soreness in the teeth or jaws, or the back of the neck. In the mandible, however, with the force directed against the basal bone (symphysis) directly, three to four pounds pressure is quite common. But this level is reached by successive increases from an original force application of considerably less intensity. If the bone itself gets sore, then we must reduce the force or provide protection through padding of the chincap itself.

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As we know, not all orthodontic considerations involve only anteroposterior jaw malrelationships. There are vertical problems, too, like anterior open bite. Despite the fact that there has been overeruption of the mandibular incisors with a disproportionately large distance between the apexes of the mandibular incisors and the mandibular border when compared with the apexes of the mandibular molars and the inferior mandibular margin, incisors are out of contact. The basal abnormality in these instances is vertical. Ramus height is short. As a result, only the most posterior teeth contact. Too often the ineffectual corrective efforts with toothborne appliances and vertical elastics are evident. Stimulating overeruption of the incisors produces relatively little change in the molar region and no change in the morphology of the mandible. Sometimes, there is considerable orthogenic damage done because, in effect, incisors are elongated beyond their normal position to compensate for basal problems. Obviously a basal change is essential. Such change is possible. The use of a Barton bandage to support fractured mandibles tends to close down the bite and to create temporomandibular joint disturbances in some patients where the bandage is too tight and is worn too long. The

work of Alexander[10] also indicates that the mandibular morphology may be changed. Apparently, Straub[11] is correct when he talks about the use of extraoral forces to reduce open bite.

CLASS III MALOCCLUSION

Mandibular prognathism is a good example of jaw deformity, and the nature of the problem makes it more amenable to the direct application of force to the bony base itself. Numerous growth studies have demonstrated that the face literally begins to emerge from beneath the cranium (Fig. 5) shortly after birth. Studies by the authors[9,12,13] have shown that there is a variable amount of growth at different times in the development of the child and that pubertal growth spurts do occur. In general, the girls have their pubertal growth spurt from 10.5 to 12 years of age. In boys, this growth occurs from 12 to 17 years of age, depending on individual and ethnic factors. The direction of growth is also variable. A mandible that grows in a primarily vertical direction may grow in a horizontal direction in the terminal stages of development. Most of the final growth increments in the mandible are horizontal and at least partly unmatched by maxillary growth. The only change that occurs in the maxilla is the compensatory intercanine arch width, which terminates at age 12 in girls with the end of the pubertal period and at age 18 in boys when their pubertal growth spurt terminates. This information on growth is valuable in orthopedic treatment. In Class III malocclusions, the authors' objective was to restrain all possible horizontal mandibular growth or at least to redirect it to a more vertical vector as the maxilla continued to grow in a downward and forward direction. In Class II malocclusions, the objective was to restrict horizontal maxillary growth or redirect the growth to a more vertical direction while the mandible achieved its fullest potential under the most favorable environmental and functional factors.

APPLIANCES

In patients with Class III malocclusions and open bite problems, the appliances are not as important as the amount of force used. However, the conventional metal chincap and high-pull headcap were used. Both of these appliances are obtainable commercially. In Class III malocclusions, the direction of pull was approximately along the axis from the symphysis to the condyle. In instances of open bite, the direction of pull was as vertical as possible with conventional appliances (Fig. 6). By using heavy elastics, the pressure attained was 3 to 4 pounds per side. The chincap was lined with absorbent, soft paper tissue to prevent irritation from the trapping of perspiration. Occasionally, talcum powder or zinc ointment was necessary. The patient was instructed to wear the appliance as much as possible during sleeping hours and around the house during waking hours, striving for 12 to 14 hours per day. Stress is again placed on the interrupted force principle to minimize unfavorable tissue reaction.

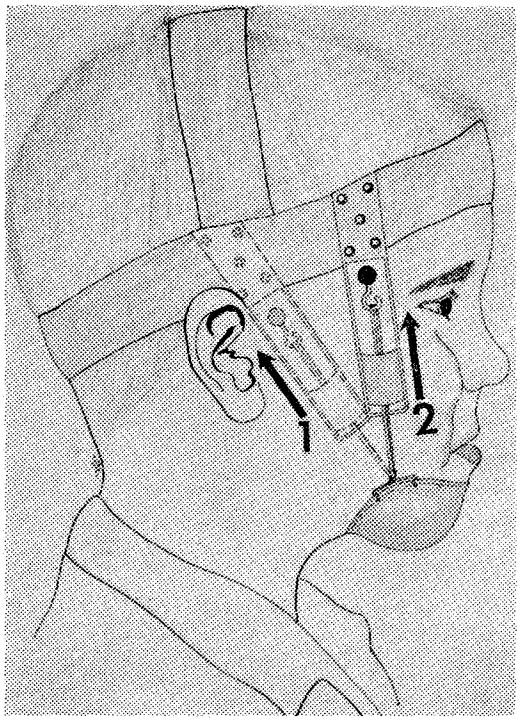


Fig. 6 ■ Direction of orthopedic traction should be determined by treatment objectives. For mandibular prognathism, pull should be upward and backward, roughly along vector from symphysis to condyle (1). For correction of anterior open bite, direction of pull should be as vertical as possible (2).

The most important time to wear the appliance is during the most prolific downward and forward mandibular growth; this correction is not short term. The average patient with scoliosis wears a brace from 2 to 4 years. The orthodontic patient must also be conditioned to long-term guidance. Too much emphasis has been placed on shortening the length of time in orthodontic treatment and the nature of the orthodontic problem has been disregarded. For Class I malocclusions, where the problem is primarily one of tooth movement, and the basal relationship and muscle activity are normal,

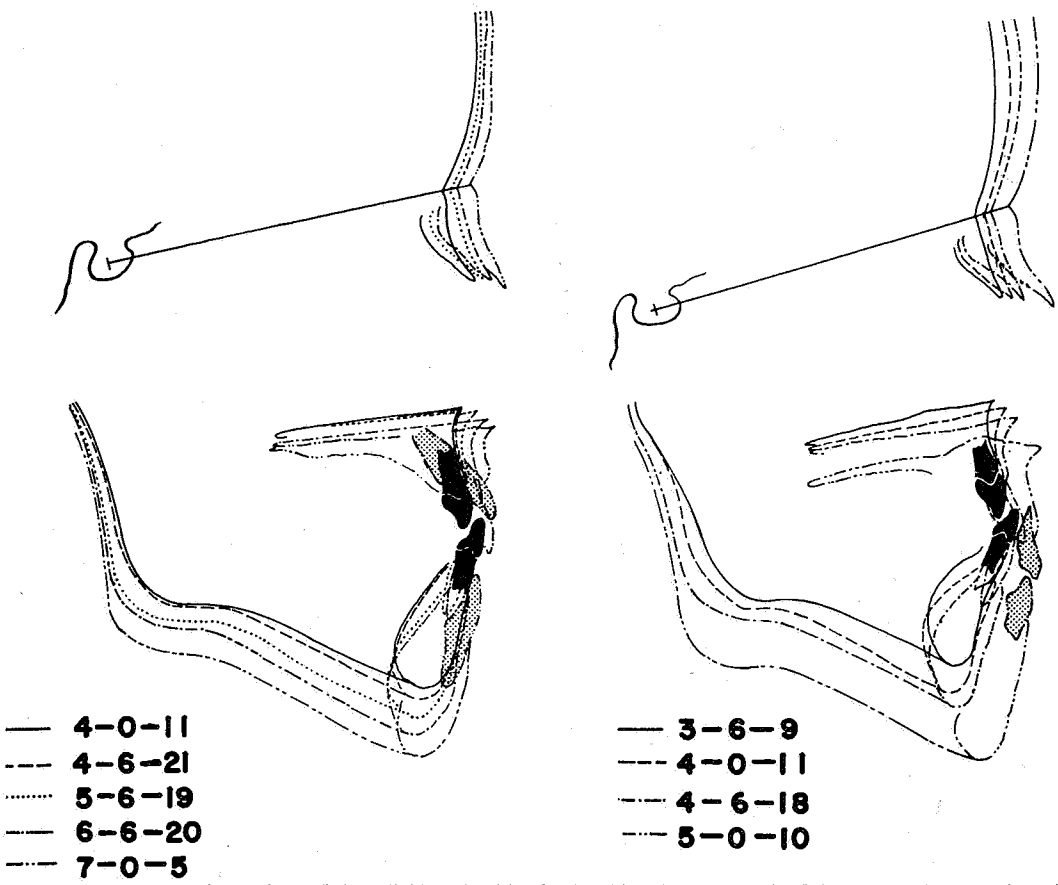


Fig. 7 ■ Cephalometric tracings of boy (left) and girl (right) with Class III malocclusions. Dominant horizontal growth was redirected into vertical direction by heavy orthopedic force from chincap therapy.

shorter treatment periods are valid objectives, consistent with tissue consciousness and awareness of the possibilities of orthogenic damage from long-term appliance wear. Root resorption, decalcification, and flattened alveolar crests are possible and must be kept to a minimum. But the authors are concerned here with tooth-moving forces, tooth-moving appliances, and dental changes associated with conventional Class I treatment. In basal malocclusions, tooth movement is secondary, or should be, with a proper therapeutic orientation. The primary problem is to establish a normal jaw relationship, which is seldom established quickly. Hence, it is detrimental to the patient to attempt tooth relationship compensation for a broader jaw problem. The results and stability of the attained position changes will reflect the limitations of compensatory changes in inclination of teeth.

The working hypothesis for this clinical study was that treatment should be for a longer period during the time of greatest growth. For Class III malocclusions, this treatment time was deemed necessary to restrict the powerful horizontal mandibular growth increments. For instances of open bite, it was thought necessary to depress posterior segments and possibly change mandibular morphology during the growth period.

For Class II problems, the challenge was considered to be to withhold horizontal maxillary growth increments while there was adjustive growth in the mandible, during the accomplishment of the fullest potential of the morphogenetic pattern. Since the orthopedic force was directed by intra-oral appliances against the maxillary dentition, anterior as well as posterior teeth, only one to two pounds of pressure at the most was applied. This is consistent with Reitan's observation that force magnitude beyond four hundred grams exceeds tooth moving potential. To more effectively influence basal bone changes, the force is di-



Fig. 8 ■ Chincaps worn for correction of Class III malocclusion and anterior open bite.

rected against all the maxillary teeth, instead of just the first permanent molars as it is in conventional Kloehn-type usage. Not only a greater amount of force may be used without undue sensory response, but there is less tendency to tip the maxillary molars distally, impacting or diverting the second or third molars.

Treatment over several years was considered desirable; thus, the most profound and permanent changes on the bony structures could be exerted. Subsequent experience substantiated this premise. In Class III malocclusions, the age of the patient when the appliance is placed is significant. The work of Moss[14] on his functional matrix theory and that of Koski[15], questioning the supposed dominance of the condylar growth in the mandible, indicate the interrelationship between the growth of the soft tissue structures and bone. Not enough is known about the mechanism of mandibular growth. However, the amounts of growth can be measured, and clinical investigators think that the direction of growth can be influenced in the same manner that the functional matrix influences it.

The growth studies of the authors on children show the dominance of mandibular growth, particularly during the first 2 years of age. However, a Class III malocclusion seldom manifests itself before the child is 2 years of age. To restrict growth during the first 2 years of life by orthopedic force application might be premature unless there is a strong heredity predisposition and similar sibling tendencies. Although the direction of mandibular growth is more vertical in children 2 to 6 years of age (Fig. 6), some beneficial effects may be achieved by force application (Fig. 7, 8, 9). The adaptive or homeostatic response of the adjacent tissues will then augment the correction instead of enhancing the abnormal mandibular prognathism. Clinical experiences show that the amount of force application and the length of wear per day need not be as great as is required later. Tissue response is thus more favorable in most instances. Furthermore, conventional intraoral appliances are not necessary.

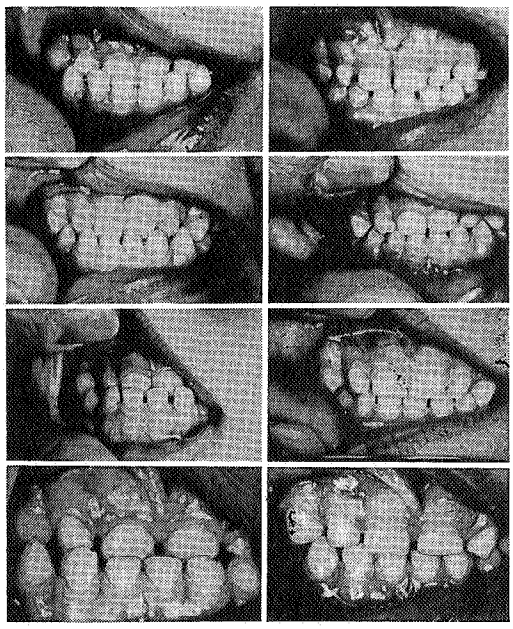


Fig. 9 ■ Class III malocclusions corrected with chincap and orthopedic force only. No appliances were worn on teeth.

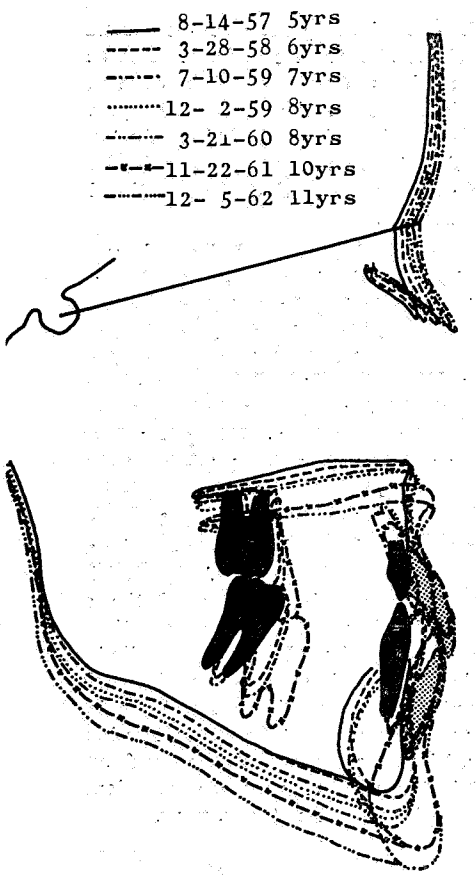


Fig. 10 ■ Series of cephalometric tracings made over 6 years shows intermittent wear of orthopedic chincap. Patient wore the appliance from 5 to 8 years of age and from 10 to 11 years of age. Note dominant vertical growth during time appliance was worn and dominant horizontal growth during time appliance was not worn.

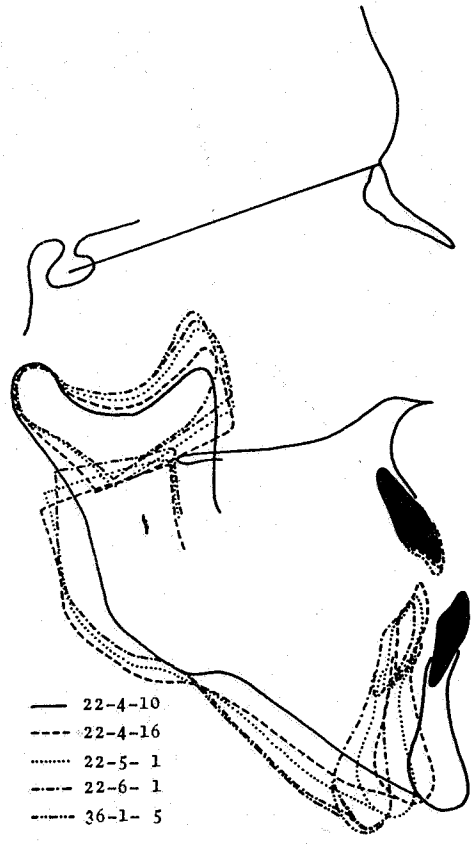


Fig. 11 ■ Mandibular resection for Class III malocclusion. Note opening "V" in region of ramus resection. Resultant open bite is coupled with nonvital lower incisors, poor tissue health, inability to incise food, and speech impediment.

The orthodontist may need to perform some corrective procedures at a later date, but the magnitude of such correction is reduced, and the prognosis is improved.

The philosophy of facial orthopedics in Class III malocclusion demands that interceptive remedial therapy is given and that the anteroposterior basal malrelationship is corrected when the patient is young. As the headplate tracings in Figure 7 and 10 show, growth of the mandible is redirected primarily, converting the horizontal impetus into a vertical component. Since the orthopedic appliance (extraoral appliance) is worn only part time, the withholding of horizontal growth is not complete, but it is sufficiently adequate to permit the basal change as the maxilla grows in an uninhibited manner during the appliance guidance of mandibular basal change.

With the chincap and extraoral appliance, only enough force at the right time should be applied to maintain a normal anteroposterior jaw relationship. The force required depends on the dominance of the morphogenetic pattern, the severity of the initial basal malrelationship, the time of the first force application, the length of wear per day, and the level of patient cooperation and tissue response. It is not possible to predict accurately the precise role of each factor before treatment. Thus, the length of time of actual treatment and the amount of force application is only an approximation when treatment is begun. The orthodontist must continually examine the occlusion and the progress with successive cephalometric radiographs. A continuous period of chincap wear or several short periods of wear may be necessary (Fig. 10). All patients must expect to be kept under

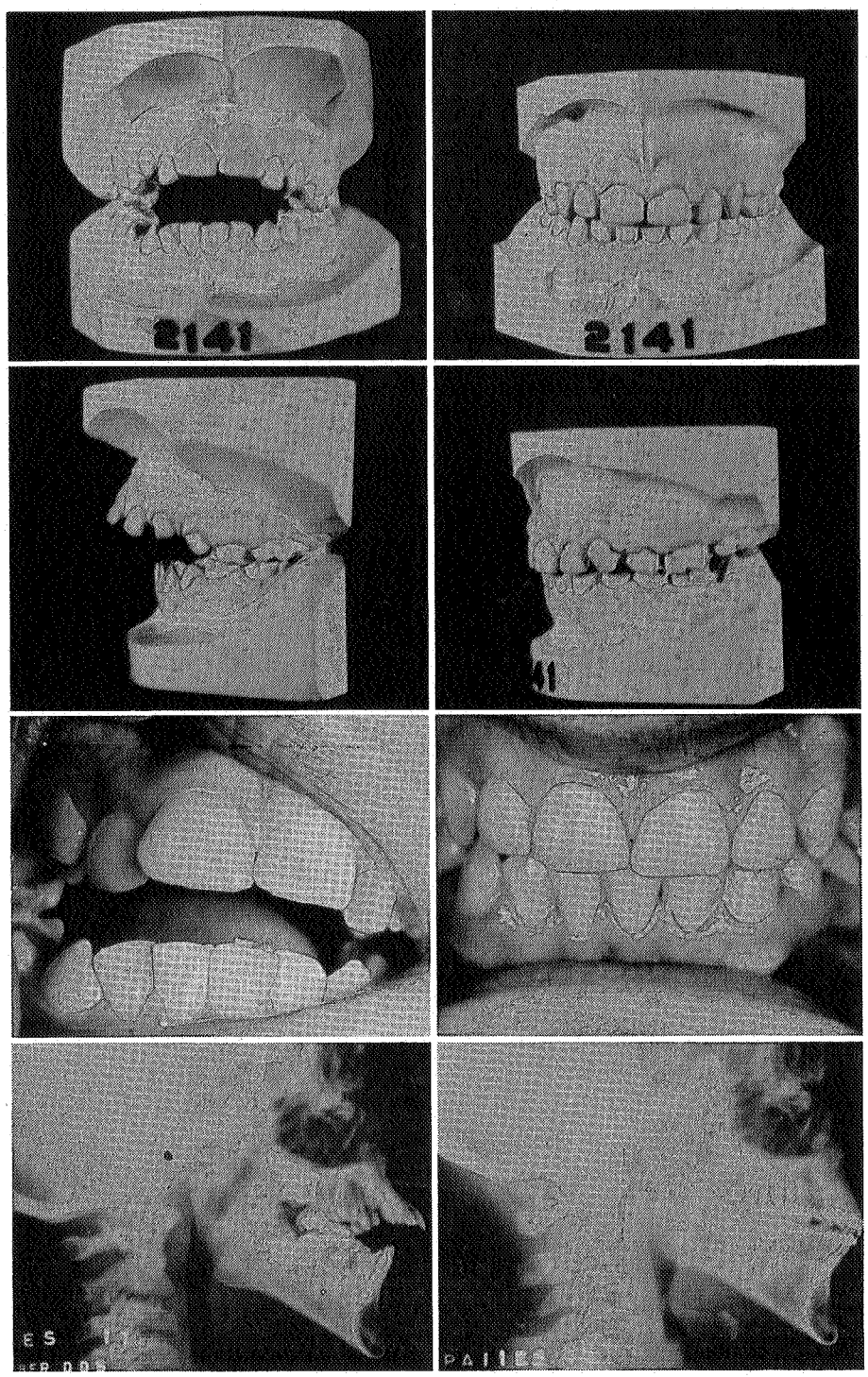


Fig. 12 ■ Cast, intraoral photographs and cephalometric films taken before (left) and after (right) correction of severe open bite by strong extraoral chincap therapy in conjunction with conventional orthodontic treatment.

	Age (yrs.)			
	11	12	14	15
SNaA	77.0	77.0	77.0	77.0
AB diff.	8.0	5.0	5.0	5.0
NaS-GoGn	49.0	45.0	44.0	42.5
Ul-NaS	107.0	93.0	92.0	95.0
Ll-GoGn	87.0	92.0	94.0	95.0
Ul-NaPg (mm.)	16.0	8.0	6.0	6.0

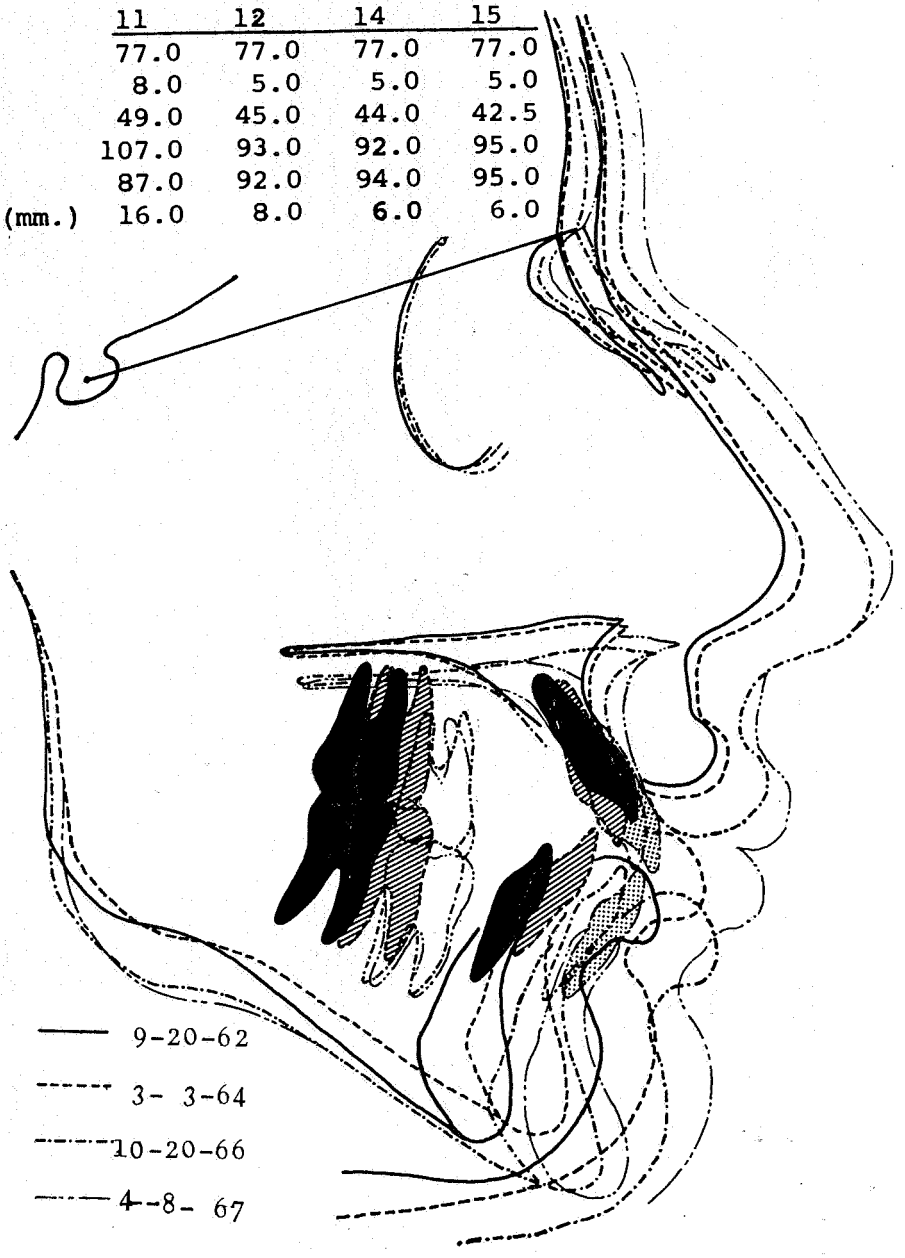


Fig. 13 ■ Cephalometric tracings of patient in Figure 12 before, immediately after, and 2.5 years after orthodontic treatment. Mandibular plane angle closed from severe 49 degrees to 44 degrees with response similar to that observed with use of Milwaukee brace. SNaA is angle of sella-nasion to point A (subspinale); AB diff. is the difference in angle between point A (subspinale) and point B (supramentale); NaS-GoGn is angle of nasion-sella to gonion-gnathion; Ul-NaS is inclination of upper incisor to nasion-sella; Ll-GoGn is axial inclination of lower incisor to gonion-gnathion, and Ul-NaPg (mm.) is linear measurement from upper incisor to nasion-pogonion.

supervision for an indefinite time, and it is apparent that growth guidance during the most active growth periods is essential. Thus, although a chincap is placed when the patient is 2 to 3 years of age, the orthodontist must not expect to discontinue treatment until the end of pubertal growth of the patient.

The object of therapy is to work with the biologic processes and the knowledge of growth and development. Cephalometric research has shown that there is dominant mandibular growth in the terminal stages of puberty, particularly in boys. In girls, chincap wear may usually be terminated when the patient is 12 or 13 years of age since insignificant amounts of growth occur after puberty. For boys, however, the wearing of the chincap may be necessary until the patient is 18 years of age.[9] The individual development pattern, whether accelerated or retarded, will influence this decision.

At present, all the reasons for the strong Class III tendency and the constant effort to reassert itself in the developing child are not understood. The word "pattern" is nebulous, and it is thus difficult to assign specific values. Also, as Sicher[16] has shown, whenever there is a struggle between muscle and bone, bone yields. The functional matrix theory with its dominance of soft tissue over bony tissue seems to possess considerable validity. Although it is possible to effect bony relationship changes or anteroposterior corrections in jaw position, the functional matrix may produce forces that operate in the reverse direction to recreate the original abnormality. But adaptability, or homeostasis, is a fundamental phenomenon of physiology, and muscles and soft tissue will adapt to some degree over a period. Thus, the orthopedic concept of heavy extraoral force application, guiding mandibular growth in the Class III malocclusions, is to keep the accomplishment of pattern under control, to depress the horizontal components of mandibular growth as well as that of the functional matrix that influences mandibular growth, and to cause the adaptive or homeostatic changes that will retain the therapeutic accomplishment rather than to cause a reversal to the original morphology and spatial relationship of the jaws. These objectives may be obtained only through indefinite guidance. However, because the appliance is simple, the wearing time is only partial, the appliance is not subject to peer criticism since it is worn only at night, and the results are uniformly successful; the use of the orthopedic appliance seems to be the best method.

The mandibular resection for Class III malocclusion also has its limitations and failures (Fig. 11). The mechanical removal of excess bone and reassemblage of parts does not assure ultimate stability or guarantee that the functional matrix will not reassert its force on the bone causing retrogressive and iatrogenic changes.[17]

OPEN-BITE PROBLEMS

Alexander[10] shows the pronounced deformation that occurs in the mandible through the adverse influence of the Milwaukee brace (Fig. 4). Five to 10 pounds of force application over 20 to 24 hours per day not only causes significant flaring of the incisor teeth and depression of the posterior teeth but also causes basal changes and a recontouring of the mandible. With the closing down of the bite and the reduction in vertical face height, there is an increasingly acute gonial angle. The senior author (T.M.G.) has shown the adverse effects of this appliance as well as the use of cervical orthopedic appliances that are used for whiplash injuries and fractured cervical vertebra[9] (Fig. 4). Yet, this type and magnitude of force may be used to help patients with open bite, especially because of the low level of success with conventional intraoral orthodontic appliances.[18]

In open-bite problems, the orthodontist usually bands the teeth in the upper and lower jaws and places vertical elastics in the anterior region of the mouth to "close down the bite." This treatment requires elongating the incisor teeth. However, a perusal of the initial morphology shows that the incisors are usually in normal relationship to basal bone, but there is often overeruption of the buccal segments, often coupled with a steeper than normal mandibular plane. During vertical elastic wear, there may be some depressing influence on the posterior teeth, but the greater response is usually the stimulation of overeruption of the incisor teeth. A potential dental health hazard exists with such therapy, and the strong relapse tendency after the removal of the elastics shows the limitations of such an approach.

With extraoral orthopedic appliances using heavy, interrupted force, however, it is possible to attack the problem directly at its source—the wedging open of the occlusion by the overeruption and interceptive contact of the upper and lower molar teeth. The stability of the therapeutic accomplishment with facial orthopedics is greater because the incisor teeth are not elongated beyond their normal position, and

	Age (yrs.)			
	9	11	12	14
SnaA	77.0	77.0	74.5	74.5
SNaB	68.0	69.5	68.5	68.5
AB diff.	9.0	7.5	6.0	6.0
NaS-GoGn	43.0	43.0	45.0	45.0
Ul-Ll	128.0	148.0	128.0	128.0
Ul-NaS	105.0	82.0	89.0	89.0
Ll-GoGn	84.0	86.0	98.0	98.0
Ul-NaPg (mm.)	18.5	8.0	9.0	9.0

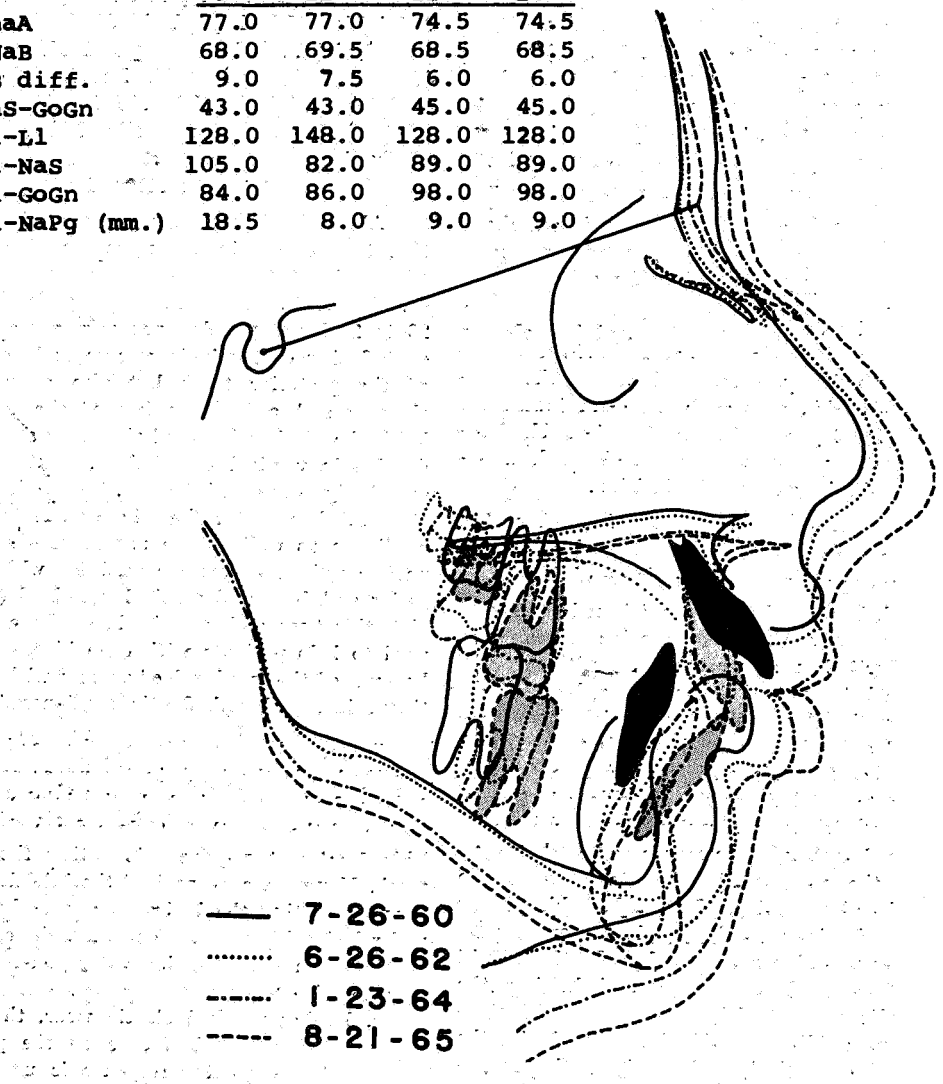


Fig. 14 ■ Cephalometric tracings of severe Class II, Division 1 malocclusion over 5 years. Despite protracted extraoral force therapy, mandibular growth was primarily vertical. Greatest benefit was to prevent forward maxillary growth after maxillary incisors had been tipped lingually. Vertical mandibular growth continued until pubertal growth spurt between 13 and 14 years of age. Removal of maxillary second molars 1 year before removal of appliances expedited establishment of normal buccal segment relationship. SNaA is angle of sella-nasion to point A (subspinale); SNaB is angle of sella-nasion to point B (supramentale); AB diff. is difference in angle between point A (sub-spinale) and point B (supramentale); NaS-GoGn is angle of nasion-sella to gonio-gnathion; Ul-Ll is inclination of upper incisor to lower incisor Ul-NaS is inclination of upper incisor to nasion-sella; Ll-GoGn is axial inclination of lower incisor to gonion-gnathion, and Ul-NaPg (mm.) is linear measurement from upper incisor to nasion-pogonion.

the buccal segments are depressed. If this treatment is done during a period of fairly rapid growth, the change can be effected in a relatively short period (Fig. 12, 13). It is necessary to continue observation and perhaps partial extraoral appliance wear while the homeostatic responses are developed to augment the morphologic change rather than to produce retrogressive changes. Frequently, however, intraoral appliances must be used in conjunction with the extraoral appliance. But the significant basal change and the reduction in treatment time are apparent to the patient and the orthodontist.

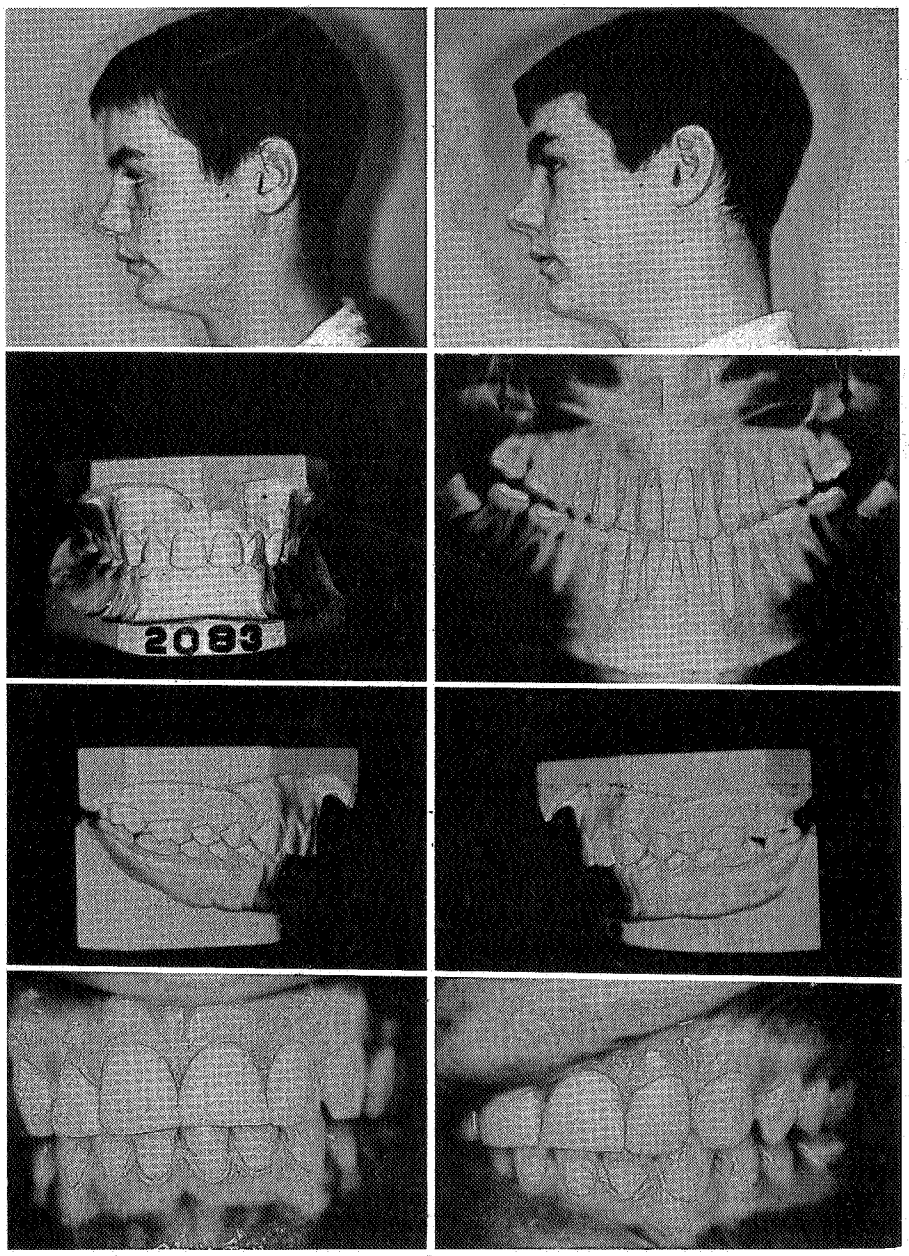


Fig. 15 ■ Congenital absence of maxillary third molars in patient provided sufficient room at posterior end of alveolar trough to permit retropositioning of maxillary dentition, correction of Class II relationship, and elimination of excessive overbite. Growth increments were favorable, but possibility of moving maxillary arch posteriorly was important.

CLASS II MALOCCLUSIONS

Force on bone during a growth period influences the direction of growth and may influence the amount of growth. Of particular importance, however, is the direction of growth. Ample experimental and clinical evidence indicates that Class II, Division 1 malocclusions can be eliminated routinely, largely through extraoral force.[19] In most instances, the magnitude of force has been within the threshold of tooth movement. Thus, considerable effort has been spent to move the maxillary molars distally. If

the growth is favorable, in the right direction and in the right amount, there may be minimal unfavorable tooth changes, such as excessive tipping of the first permanent molars, impaction of the second and third molars, or excessive lingual inclination of the maxillary incisors. If treatment time is protracted and growth increments and direction are not particularly favorable, the chances of excessive tipping of the first molars, creation of buccal cross-bite of the second molars, or deeper impaction of the third molars are greatly increased. The maxillary incisor crowns will probably become lingually inclined with the apexes thrust labially although the force is applied against the first molars when there is a full maxillary appliance and the molars are tied into the maxillary arch.

If the force is of great intensity and beyond the threshold of tooth-moving range, then the effect is probably on the maxillary base itself, and the teeth merely serve as a handle to transmit the force to their base. Ideally, it would be better to apply pressure directly on the maxilla rather than through the teeth. In the mandible, this technic is simple, but, in the maxilla, there are problems. Nevertheless, with heavy, massive, and interrupted forces, it is possible to achieve essentially the same result. Histologic work by Reitan[20] has confirmed this thesis, showing excellent tissue response and minimal or nonexistent tissue damage.

The percentage of Class III malocclusions, including instances of Class I open-bite malocclusions, is relatively small in orthodontic practice. The percentage of Class II malocclusions is high — usually more than half the total active practice load. Certainly, the orthodontist should find some form of therapy that will produce the basal change needed, reducing the need for compensatory tooth movement changes and radical extraction procedures. When Begg[7] criticizes moving the molars distally with extraoral force, he is correct, if it is the objective of the extraoral appliance to move the teeth distally. He says that this movement is against the normal direction of mesial tooth migration and that the chances of impacting second and third molars are greatly enhanced. If it is the objective of orthopedic extraoral force not to move teeth distally but merely to withhold maxillary growth, this criticism is invalid.

There are times when the first molars should be moved distally. For example, when it is probable that growth direction and growth increments will not be sufficient to produce the basal change, the dental compensation must be made with the removal of maxillary second molars (Fig. 14). Also, if third molars are congenitally missing, this space may be used in the alveolar trough to correct the anteroposterior malrelationship (Fig. 15, 16). But these instances are infrequent.

Generally, if the orthopedic philosophy is used, the objective of therapy should be to reduce the basal malrelationship so that the teeth are in a Class I malocclusion. This treatment eliminates the need for adaptive and abnormal muscle activity. It has been the authors' experience that the abnormal muscle function is then spontaneously eliminated. The lower lip no longer cushions the lingual of the upper incisors; the hyperactive mentalis muscle activity disappears. The tongue posture improves with the dorsum more nearly approximating the palatal surface. Thus, the soft tissue reacts with favorable homeostatic responses as a result of the basal bony changes.

With heavy increments of force, the direction of force application is less important. Whereas, theoretically, the ideal direction would be upward and backward by use of the occiput as the base of operation, the cervical anchorage seems to be relatively effective. It is the amount of force beyond the tooth-moving range that is important. This force is produced with a strong metal spring, not with the conventional light latex elastics (Fig. 17).

The precise effect of this heavy force on the back of the head or on the cervical vertebra is not known. However, there is a heavy postvertebral muscle splint that cushions the cervical vertebra. This muscle force resists the application of force from outside. Clinically, the authors have had no adverse signs of the effect of the postcervical force application. Since there is an intervening muscle splint for the cervical region and none in the occiput to protect the cranium, the authors prefer to use the cervical region as the base of force delivery for Class II correction. A broadbase occipital assemblage could be constructed that would be equally or more effective, but it is secondary to using heavy, interrupted forces that are transmitted to the maxilla itself to prevent movement of teeth. To achieve this objective, the intraoral appliance is such that the force is transmitted not only to molar teeth but also to the incisor teeth. Thus, the arch wire is stopped at the molars, but the extraoral appliance attaches to the anterior portion of the arch, and

a similar amount of force is absorbed by the incisors. The loops for attachment of extraoral appliances are horizontal, which makes it easy for the patient to place and remove the extra-oral force arms. This ease of handling enhances the patient co-operation and reduces appliance breakage. The horizontal loops do not irritate the lips. They also serve as closing loops if there is some spacing. Then the circular molar stops that have been bent into the arch wire may be moved slightly mesially and tied back to activate the horizontal loops anteriorly, closing the existing space.

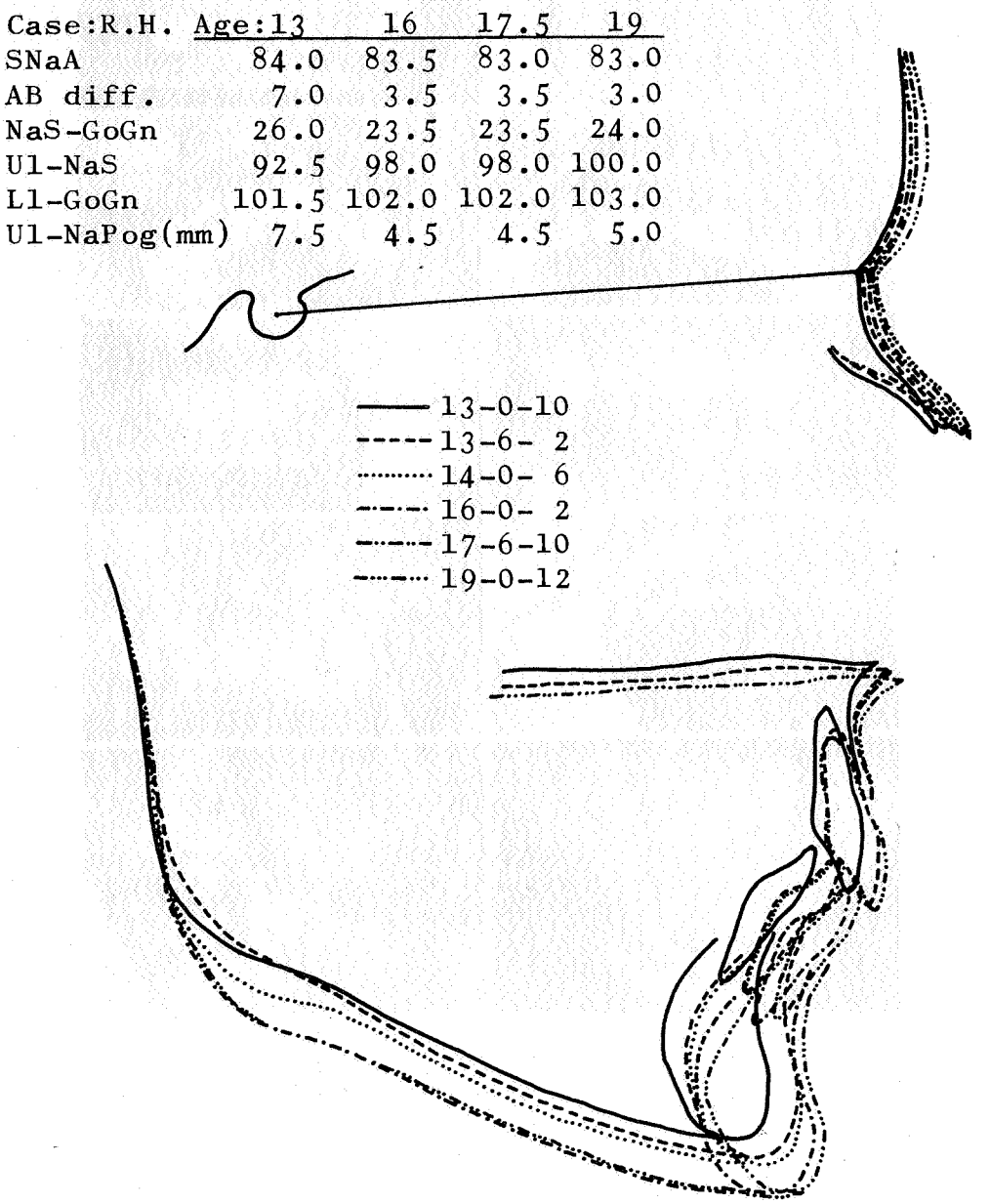


Fig. 16 ■ Cephalometric tracings of patient shown in Figure 15. SNaA is angle of sella-nasion to point A (subspinale); AB diff. is difference in angle between point A (subspinale) and point B (supramentale); NaS-GoGn is angle of nasion-sella to gonion-gnathion; UI-NaS is inclination of upper incisor to nasion-sella; LI-GoGn is axial inclination of lower incisor to gonion-gnathion, and UI-NaPog (mm.) is linear measurement from upper incisor to nasion-pogonion.

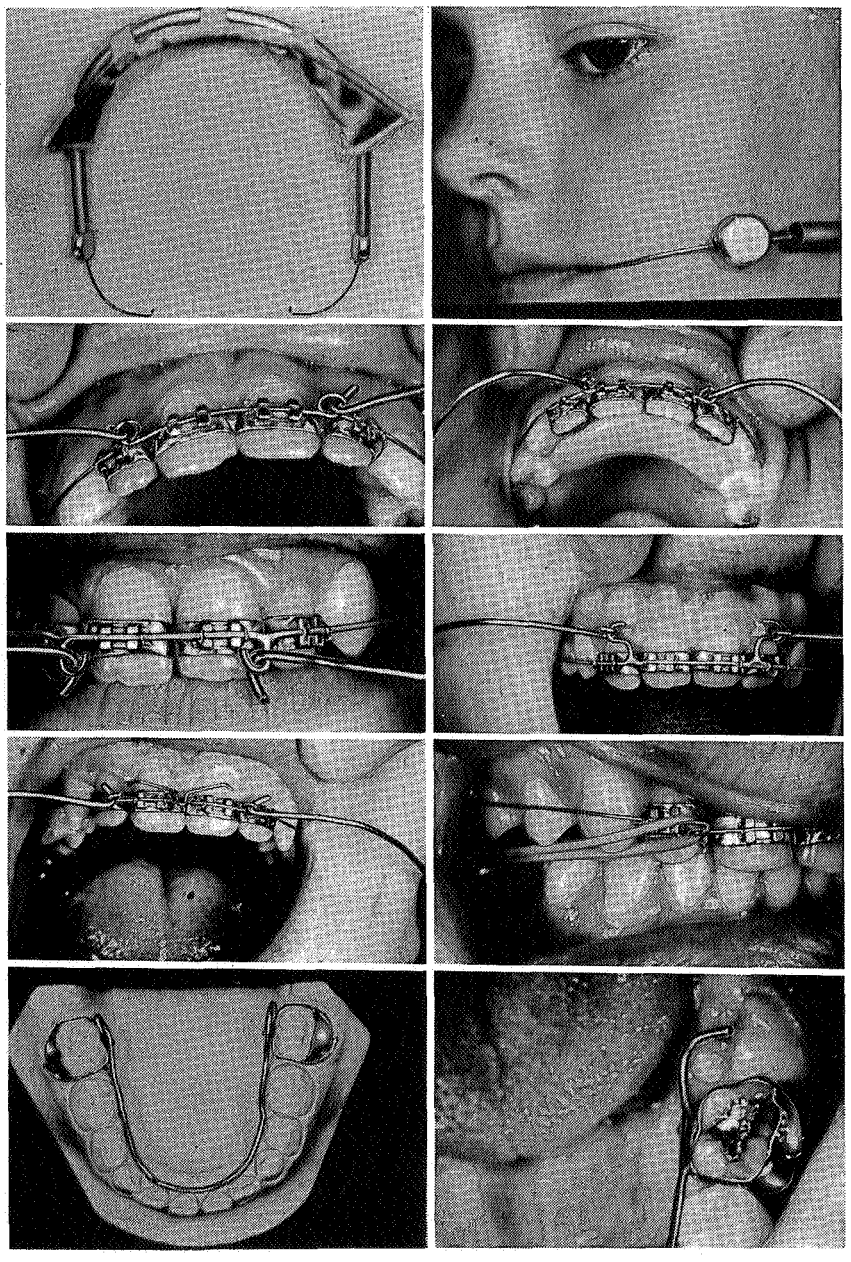


Fig. 17 ■ Orthopedic force application. Spring-loaded aluminium tube with adjustable metal arms and tension control. Pad fits around neck. Adjustments are made by Allen wrench in circular disk (top row). Wide twin-edgewise brackets on central incisors, medium width twin-edgewise brackets on lateral incisors have brackets 0.022 by 0.028 inch. Second row shows bands with steel round arches of 0.020 inch with horizontal loops and insertion of cervical appliance arms from beneath with ends facing up. If biteplate is needed, it may be used as shown in second row, right. Rectangular arch may be used (third row) for torque, with hooks soldered below arch at central-lateral embrasure or above arch to augment torque adjustment. Torquing springs may also be soldered on base arch of 0.020 inch (fourth row). For part-time elastic traction, horizontal loop bent in arch will serve with lower fixed lingual arch (bottom row). For patients who have had maxillary second molar extraction, occlusal extension is required for central fossa of mandibular second molars (bottom, right).

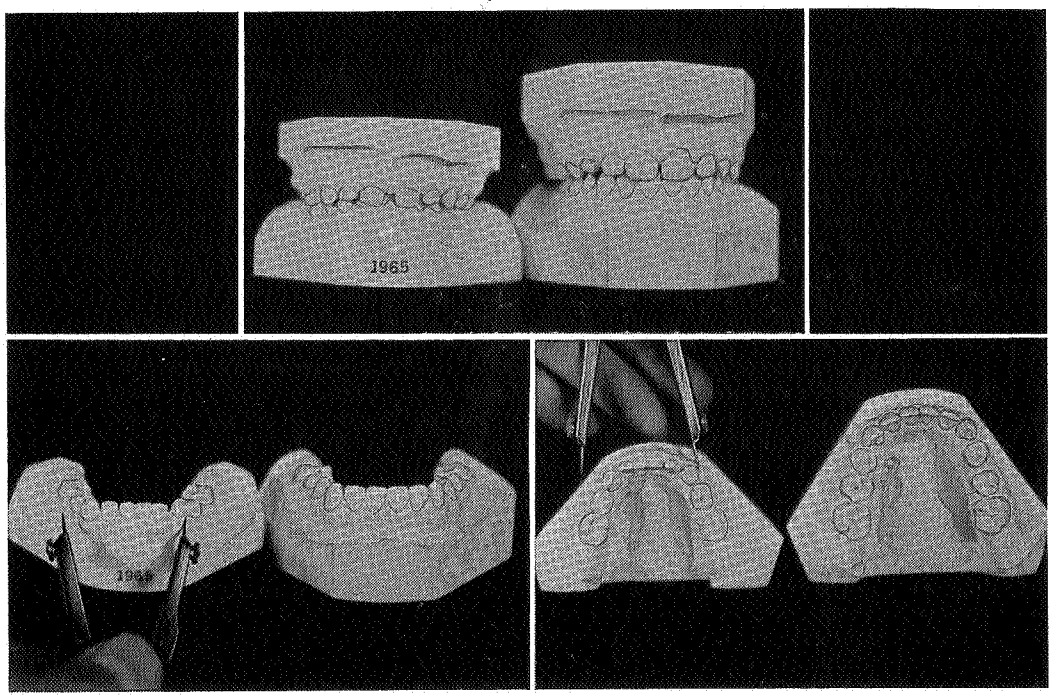


Fig. 18 ■ Deep overbite in deciduous dentition tends to constrict mandibular anterior segment. Significant arch width increase can be achieved in mandibular intercanine distance in these patients with proper use of biteplate, which also serves to reduce or eliminate functional retrusion tendencies.

It is desirable to insert the extraoral force arms into the horizontal loops from below to reduce breakage and the frequency of loose bands and to facilitate removal of the extraoral appliance. Figure 17 shows that the loops are placed between the lateral and central incisors to stabilize the arch wire on both sides of the loop attachment. Placement distal to the lateral incisor is more likely to loosen the lateral incisor band or the canine band, which is harder to maintain on the tooth anyway. Also, it is more comfortable to have the extraoral force insertion away from the corners of the mouth.

Since this technic has been used over 20 years, modifications have been made. Thus, the construction of horizontal loops bent into the arch wire facilitates placement of extraoral force arms and reduces appliance maintenance problems. The use of a foam rubber pad on the back of the neck increases the comfort and decreases the possibility of irritation. The 0.045-inch arms that insert into the horizontal loops are kept away from the corners of the mouth, and the entire appliance has minimal contact with the face (Fig. 17). Auxiliary pads may be placed over the ends of the tubes and the metal disk if there is complaint of discomfort.

As in Class III malocclusions, a thorough knowledge of the developmental pattern is essential for proper treatment response. Constant effort to maintain optimum patient cooperation may make the difference between success or failure. The appliance must be worn a minimum of 10 hours and preferably 14 hours per day. Thus, it is necessary for the patient to find 1 or 2 additional hours each day to wear the appliance in addition to sleeping time. Judging from the clinical response, it is apparently more desirable if this time can be distributed throughout the day in shorter periods of 10 to 15 minutes. However, when growth is favorable as during the pubertal growth spurt, the additional hours are so important.

The magnitude of the maxillomandibular basal malrelationship is a conditioning factor. No formula can be developed to indicate movement per unit of time, and there is no cephalometric triangle to indicate what the ultimate tooth position will be. Consistent reduction of apical base difference, however, is to be expected, and the remaining tooth movement is

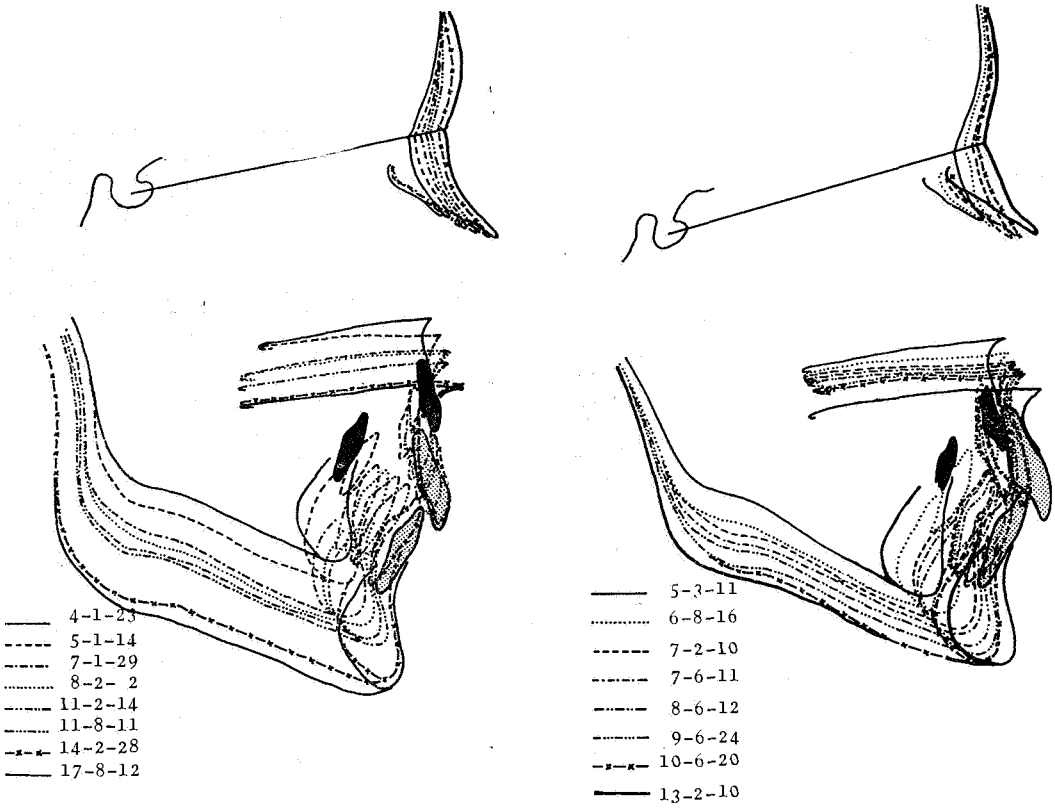


Fig. 19 ■ Orthopedic effect on maxillary complex as result of heavy, intermittent force applied for 9 to 14 hours per day. Maxillary growth is primarily vertical in direction, coupled with downward and forward mandibular growth direction. Tooth movement is minimal.

similar to that associated with most Class 1 problems. The percentage of extractions of first premolars is reduced significantly. Since the mandibular arch is essentially normal in most Class II, Division 1 malocclusions, it is often possible not to band the lower arch. Where there is a unilateral buccal segment correction, a lower fixed lingual appliance may be placed, and unilateral light elastics may be worn during the day to augment the extraoral appliance at night (Fig. 17). With a deep overbite, the use of a biteplate may be indicated. It is questionable how much benefit may be achieved with biteplate wear. But, as Matthews[21] has shown, if worn constantly, significant improvement may be achieved (Fig. 18). At least, it eliminates the overclosure and functional retrusion tendency. The dominance of posterior temporalis and masseter muscle fibers, as shown in myographic studies by Moyers,[22] is reduced by biteplate wear. This eliminates a strong retrusive force on the mandible which conceivably could restrict the development of the fullest potential of the pattern. Accessory armamentaria may be the lower soldered, fixed lingual appliance with molar tubes on the first permanent molars to serve for possible part-time elastic traction and the maxillary biteplate. Treatment response dictates their use.

In severe Class II problems, orthopedic therapy should be instituted early, with guidance for 6 to 10 years or even earlier (Fig. 19, 20). If treatment of routine Class II, Division I malocclusions is timed properly, the most favorable tissue response is seen in girls from 10.5 to 12 years of age, at the height of the pubertal growth spurt, and in boys from 12.5 to 17 years of age. It is more difficult to predict the onset of the male pubertal growth spurt, but a study of the family pattern is helpful. Generally, the orthodontist has been completing treatment of boys with Class II, Division I malocclusions too early and has been making tooth compensations when later orthopedic force

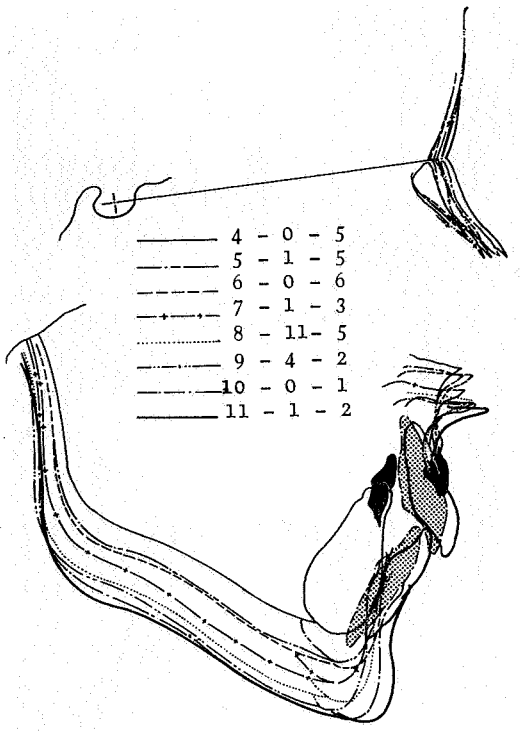


Fig. 20 ■ Same effect as shown in cephalometric tracings of patients in Fig. 19; however, mandibular growth direction is least favorable in this patient.

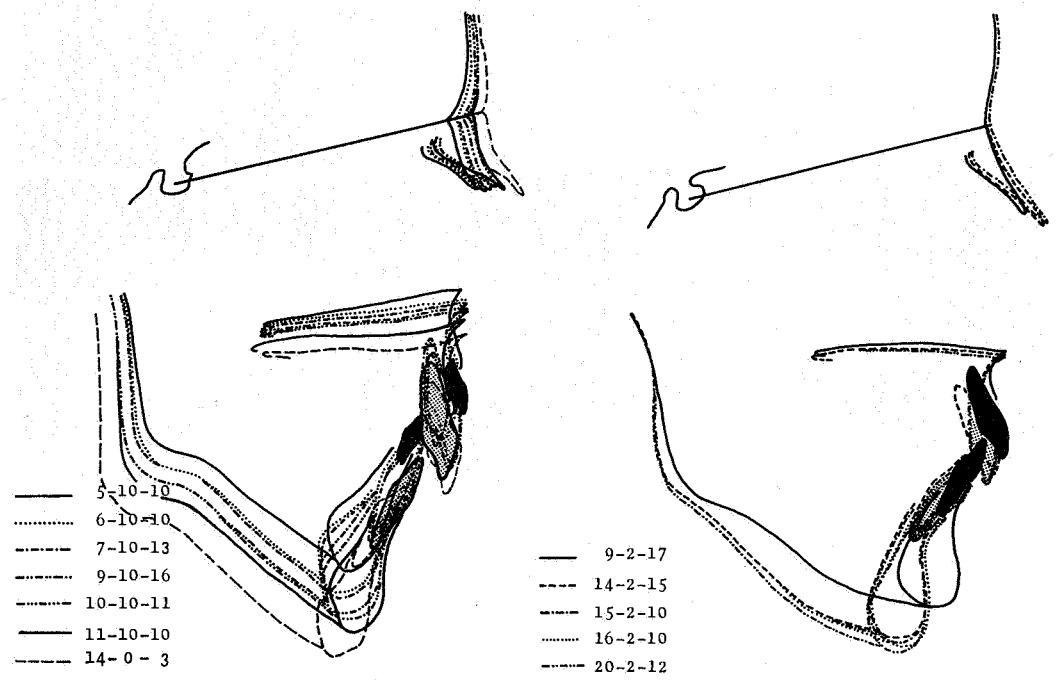


Fig. 21 ■ Cephalometric tracings of two patients with heavy orthopedic force against maxilla, but with unfavorable growth direction in mandible. Downward and backward mandibular development mitigates strongly against therapeutic success. In tracing on right, complete appliances, removal of first premolars and concentrated torque were all used, but increasingly convex profile could not be prevented.

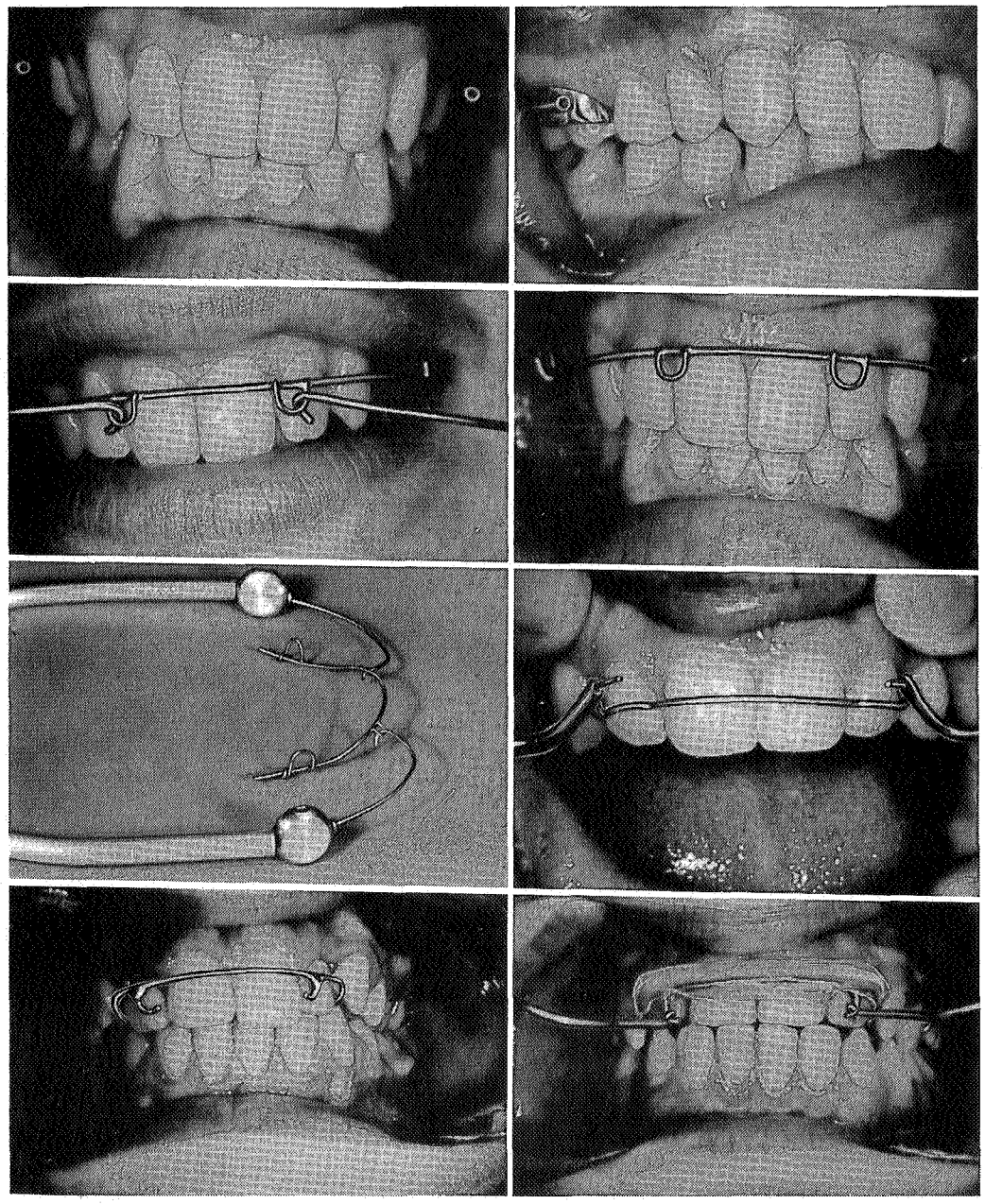


Fig. 22 ■ Active retention with extraoral force for Class II malocclusions. Class II relapse tendency (two top rows) is being reduced and held with 0.045-inch arch under patient control. First molars are banded. Arch wire is inserted each night, and cervical spring appliance is attached to loops soldered to arch wire in lateral incisor area (second and third rows, left). Extraoral appliance may be attached directly to modified Hawley retainer (third, right, and bottom row). Acrylic resin may be added to labial bow section to stabilize removable appliance (bottom, right).

against the basal malrelationship would have made this treatment less necessary. If compensations within the dental arch are made, later horizontal mandibular growth increments may undo much of what has been done, producing irregularities in the mandibular anterior segment.

Thus, the period of extraoral force should be increased, not necessarily all within one period. It must be later than it has been used

on boys in the past. In severe instances, it may be necessary to institute orthopedic extraoral force in the mixed dentition in addition to the use of the biteplate to eliminate functional retrusion and to provide a more favorable environmental balance. Even then, with vertical or downward and backward developing patterns, the prognosis is usually poor to fair (Fig. 21).

The use of orthopedic extraoral force as a retaining device must not be underestimated. Class II, Division I malocclusions are basal problems, and the relapse tendency can be reduced only by attention to the basal malrelationship problem. A Hawley retainer by itself does little or nothing. Thus, the continued use of an extraoral appliance with the arch wire under patient control is good (Fig. 22). In the average patient, active treatment is over 18 to 24 months during pubertal growth. This treatment is followed by a retention period of similar duration with a heavy 0.045-inch arch wire under patient control. A biteplate may also be used to prevent relapsing overbite. Therapy is instituted in the mixed dentition and a second or third period of treatment during the permanent dentition is almost always necessary. The patient should be aware of the growth-linked nature of the problem and should not expect to have the problem solved immediately.

SUMMARY

Orthopedic therapeutic measures with heavy and interrupted force against the bone may be used successfully in orthodontics. Greater use of this type of extraoral force is recommended because of its superior ability to correct basal jaw anteroposterior malrelationships, the major problem in most malocclusions treated by orthodontists. In addition, there is greater stability, a lower percentage of tooth extractions, minimal use of intraoral appliances, less attendant orthogenic damage (decalcification, root resorption, and so forth), minimal chair time, and longer intervals between adjustments. Histologic and radiographic examination corroborate the impression of clinical success. An occipital base of anchorage appears more satisfactory for correction of Class III mandibular prognathism. In instances of open bite, the direction of restrictive force must be as vertical as the design of the cranial cap will permit. In Class II, Division I malocclusions, a cervical source of anchorage is satisfactory, producing minimum tooth position changes if the magnitude of force is interrupted and beyond tooth-moving range.

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