Bio-Progressive Therapy, Part 8: Bio-Progressive Mixed Dentition Treatment

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For most orthodontists, early treatment poses the universal enigma: Are the rewards to be gained by early intervention worth the time, effort, and money expended to reach the sometimes elusive objectives? Many of us feel that we are being coerced into early intervention of problems by our socio-economic system, the natural tendency to alleviate the problem when it is noticed, and the somewhat overstated concept of "interception versus correction".

The purpose of this article is to clarify the basic objectives of early treatment and thereby elucidate, from a practical standpoint, those cases that truly deserve early therapy and those cases that would be best treated after full eruption of the permanent dentition. It is also important to maintain a definite understanding of our specific objectives for each individual case so that, after first phase procedures, we can look back and verify that something was accomplished for that patient.

Once a decision has been made to approach an individual case from an interceptive standpoint, a mechanical medium for reaching specific objectives is needed. Basic mechanics for reaching these objectives will be demonstrated. We will not refer to the term preventive, as it is assumed that anything the orthodontist would do-- even the decision not to treat-- should be preventive.

Objectives of Early Treatment

1. Resolve Functional Problems

If no other objective is accomplished in the first phase of treatment, it is critical that functional problems be resolved. The practical definition of a functional problem is anything that disturbs the growth, health, and function of the temporomandibular joint complex.

2. Resolve Arch Length Discrepancy

All things being equal, we would like to resolve arch length discrepancies early so that those cases within the bounds of nonextraction therapy will be approached in a manner that allows for their successful conclusion without removal of permanent teeth.

3. Correct Vertical Problems

As it is a major tenet of the Bioprogressive Therapy that the overbite be corrected before the overjet is corrected, it is most efficient to resolve the deep bite problem or the open bite problem prior to, or in conjunction with, treatment of the overjet problem.

4. Correct Overjet Problems

In order to create an acceptable maxillomandibular balance, as well as a Class I occlusion, a combination of orthopedic-orthodontic movements is warranted.

Growth Concepts

In order to describe what would be considered normal growth, health, and function of the temporomandibular joint complex, it is important to develop a concept of normal growth of the mandible. By understanding the evolution of different concepts concerning mandibular growth, and placing them in light of current research, it is possible to more clearly define both the reasons for temporomandibular joint disturbance as well as to dictate an effective therapy to restore a normal growth posture.

For many years, orthodontists have lived with the concept of upward/backward growth of the condyle as the norm in mandibular development. We used the supposedly stable mandibular plane and points on the symphysis as superimpositional references to delineate an upward and slightly backward eruption of the teeth (Fig. 1).

Early research by Hunter, using the pig mandible and a wire circumferential to the ramus, indicated that there was resorption on the anterior portion of the ramus and apposition on the posterior aspect of the ramus. Later Brash, repeating Hunter's investigations and, using the same type of experimental animal, came to a similar conclusion about growth of the mandible. Brodie referred to cartilaginous proliferation on the superior-posterior aspect of the condyles giving the mandible the same downward and forward growth exhibited by the maxilla. This all seemed to make good sense. The mandible was pushed downward and forward as the back side of the condyle filled the fossa.

Sicher and DeBrul, in their text The Adaptive Chin, demonstrated that, from an anthropological standpoint, protuberance menti (suprapogonion) is a stable landmark upon which superimpositional registration could be made. This later was verified with bone implant studies.

Only later did we start to think in terms of resorptive changes at B point with the movement of the dentition. Our initial references for mandibular growth and eruption of the dentition were based upon early research, limited by our ability to study the growth problem .

Our concepts of mandibular growth began to change when Bjork, with bone implants, demonstrated that the mandibular plane (our long-term stable reference point) was, in fact, resorbing during normal growth. His work also indicated that in many cases the condyles were not growing upward and backward as initially thought, but were proceeding to grow in either a straight upward or an upward/forward direction. Although at that point our overall concepts of growth of the mandible were not clear, it was realized that the mandibular plane was no longer a stable reference mark by which normal eruption of the dentition could accurately be defined.

Later, Moffett at the University of Washington, using tetracycline staining techniques on human mandibles, showed that there is a preponderance of appositional cartilaginous growth on the upward/forward portion of the condyle. A large body of knowledge began to accumulate that was beginning to undermine the long-term understanding that we had maintained about growth of the mandible. More recently, Moss began to refer to mandibular growth as a logarithmic spiral and

Ricketts proposed that growth of the mandible could be closely predicted by projecting average growth increments to anatomical structures as defined by an arc (Fig. 2).

Probably the most interesting aspect of Ricketts' work is the uncanny accuracy with which specific growth of the mandible can be defined. This is to say, if our current concepts of mandibular growth are not relatively accurate, how then can we project overall morphology of the mandible in such detail over protracted periods of time? Research continues to define more specifically not only the way that the mandible itself is growing, but also the way in which this bone fits into the overall growth of the facial complex (Fig. 3)

One thing is relatively clear from this procession of research to clarify normal mandibular growth. It has been shown that cases with stronger mandibular growth turgor have a propensity for upward/forward growth of the condyle. Conversely, cases with weak growth turgor demonstrate a more upward/backward growth of the condyle. Morphology alone suggests that the upward/forward cant or bend of the condyle and neck in brachyfacial types and the upward/backward cant and bend of the condyle and neck in dolichofacial types delineates ultimate vertical growth and forward posture of the chin in the face.

Ultimately, then a functional problem may be defined as anything which jeopardizes the normal direction of growth in an individual case. Although it might seem ideal to perhaps change the direction of growth at the extreme ends of the spectrum (extreme dolichofacial types or extreme brachyfacial types), a major objective of orthodontics is to intercept those functional problems which are causing detrimental mandibular growth response in the broad spectrum of cases (i.e., mesofacial types). It is not our intention to define the minute details of arcial growth of the mandible, but it should be noted that several distinct applications of this growth concept apply directly to our mechanotherapeutics.

1. The lower dentition normally erupts in an upward and forward direction.
2. The mandibular plane is not a reliable reference point for long-term evaluation of change.
3. In all but the dolichofacial growth patterns, the condyles grow in a straight upward, or an upward and forward direction.
4. Protuberance menti (suprapogonion) and internal mandibular reference points are our most sound areas of superimpositional evaluation.

Treatment of the functional problems, per se, means that in the broad spectrum of cases, an upward/forward growth of the condyle should be protected. We can consider anything which jeopardizes this upward, forward growth as a temporomandibular joint dysfunction and worthy of intervening treatment, regardless of the patient's age. At this time it is felt that many temporomandibular joint dysfunction syndromes are merely an extension of growth disturbance problems which began very early in life.

A Case For Laminagraphy

A most profound tool for studying normalcy in the temporal complex is the dental laminagraph.

As evaluation of the different functional problems will be in part by means of laminagraphic sections, it is important to define normal condylar location within the temporomandibular joint fossa in light of current concepts of normal growth of the mandible.

In the early 1950's, Robert Ricketts, et al, began to set standards for normal variations in the temporomandibular joint as determined by body section x-rays (laminagraphy). Although there were wide variations in the size of the fossae and the size of the condyles, it was found that, in centric relation occlusion, the condyle took a "centered" position whereby the antero-superior surface of the condyle articulated in a specific relation to the eminence. It was also noted that a joint space superior and distal to the condyles existed in normal centric relation occlusion. The space between the condyle and the eminence-- 1.5 ± 0.5 mm-- gives the clinician some idea as to the most ideal articulation between the condyle and the eminence. The space between the condyle and the roof of the fossa-- 2.5 ± 1.0 mm-- showed slightly more variation (Fig. 4).

In laminagraphic section it should be noted that the normal joint is characterized by a condyle centered in the fossa, surfaces free of rough edges (smooth contour), and absence of excessive thickening of the subchondral layers. It is reasonable to say that the most important measurement is the relationship of the upward/forward portion of the condyle to the eminence itself, as wide variances from this position (the condyle articulates off of the eminence) dictate abnormal positioning of the condyle in centric occlusion and can be indicators of abnormal growth, health and function in the temporomandibular joint complex (Fig. 5).

In order to enhance the clarity of laminagraphic sections, submentovertex x-rays are taken to evaluate exact inclination of the long axis (mediolateral) of the condyle to the midsagittal plane. Wide variations in this inclination are seen, even from side to side in the same patient. This measurement becomes especially important when accurate representation of the position of the condyle in the fossa is needed and, in a young child, with small condyles, this measurement becomes more critical (Fig. 6).

In laminagraphic section, a narrowing of the articular spaces along with sclerosis or subcondylar thickening of the bone at the articulating surfaces is commonly suggestive of beginning temporomandibular joint pathology. Obvious flattening and erosion of the condylar head can be noted in extremely young patients with abnormal positioning of the condyle due to the occlusion.

Resolve Functional Problems

Nine general categories of functional problems can be detected by clinical or roentgenographic examination of the patient at an early age:

1. Cross-mouth Interferences
2. Anterior Crossbite
3. Open Bite-- Lack of Incisal Guidance
4. Excessive Range of Function
5. Distal Displacement
6. Loss of Posterior Support-- Superior Displacement
7. Finger Sucking/Lip Sucking/ Tongue Thrust
8. Breathing and Airway Problems
9. True Class III Growth Patterns

1. Cross-mouth interferences (Fig. 7).

A. Clinical evaluation: Any condition where one or more teeth cause a shunting of the mandible in a lateral direction upon final closure could be considered a cross-mouth interference. Ordinarily, these cases can be detected by watching mandibular closure. The patient is instructed to open the mouth wide, and the path of mandibular closure is observed. Typically, with cross-mouth interference, there will be a lateral shunt into a "comfort occlusion", or a broad arc of closure toward one side or the other. In the wide open posture, usually the midline will align at wide open, and upon closure there will be a midline shift as guided by neuromuscular reflexes. These cases usually have posterior crossbite, but this condition can be caused by a single tooth or incline on a tooth. Many times the posterior crossbite will not cause mandibular shunting in the deciduous dentition due to the propensity of these teeth to wear flat and alleviate posterior interference. The mandibular shunt will often begin with the eruption of the upper and lower permanent first molars.

B. Laminagraphic evaluation: As the mandible shunts to one side or the other, x-rays reveal that the condyle is typically brought down on the eminence on one side and is either ideally seated or distally positioned on the opposite side. The opposite side from the shift acts in a translatory manner, while the shifting side condyle is brought into apposition with the greatest height of the eminence.

C. Resultant growth changes: Whereas the translatory condyle may experience normal growth, the opposite side condyle will commonly demonstrate restricted growth on its antero-superior surface and increased growth in the posterosuperior surface will ensue. Long-term growth effects will demonstrate a cant in the occlusal plane, abnormal ramal heights, abnormal alveolar process heights, and abnormal chin positioning.

D. Timing and method of treatment: Where mandibular shunting exists, the cross-mouth interference should be relieved as soon as it is noticed. In the deciduous dentition, this may mean an equilibration of a posterior tooth, or canine, to alleviate the shunting. If the problem is due to a bilateral constriction of the maxillae, expansion therapy is indicated usually when the upper first molars have erupted sufficiently to allow placement of an expansion appliance.

2. Anterior crossbite (Fig. 8).

A. Clinical evaluation: When one or more anterior teeth are severely malposed, the mandible may be guided forward by the anterior interference. Clinically, when the mandible is nudged gently in a distal direction and closed, the area of anterior interference can easily be detected. It is not uncommon to experience anterior displacement in cases with extreme crowding and/or situations of ectopic eruption of incisors.

B. Laminagraphic evaluation: When anterior mandibular shunting occurs, often both condyles are brought down toward the apex of the eminence (i.e., out of the fossae) and, quite commonly, articular space superior and posterior to the condyles is evidenced.

C. Resultant growth changes: As both condyles have been brought down on the eminence, upward-backward growth of the condyles is bilaterally enhanced. This can increase effective mandibular length and is believed to be a contributing factor in Class III malocclusion.

D. Timing and method of treatment: It should be determined whether the individual case is a true Class III malocclusion or simply an anterior interference. When the case is simply an anterior interference, alignment of one or more teeth to prevent the interference is ideal. This is most easily accomplished prior to full eruption of the incisors or before incisal trauma damages the teeth at the site of interference.

3. Open bite-- Lack of incisal guidance (Fig. 9).

A. Clinical evaluation: During active eruptive phases, all cases at one point or another exhibit either anterior or posterior open bite. Once the eruptive process of the upper and lower incisors has been abbreviated (usually by contact with the soft tissue lip or tongue) and active eruption no longer exists, lack of proprioceptive guidance from the anterior teeth to position the condyles in the fossae allows for excessive mobility of the mandible. Clinically, these patients commonly show difficulty in finding centric occlusion. The mandible may move into three or four different positions upon request of closure. There is generally a forward shunt of the mandible (to reach out for incisal proprioception) and quite commonly the mandible can be manipulated distally by extending the thumb from the lower incisors to the upper incisor teeth.

B. Laminagraphic evaluation: The condyles are usually forward in the fossae, down on the eminence, and often there is flattening and irregularity of the antero-superior surfaces of the condyles.

C. Resultant growth changes: Loss of guidance of the condyle in the fossa causes abrasion or wear due to the excessive anteroposterior slide. This can result in growth at the apex of the condyle and increase upward/backward growth.

D. Timing and method of treatment: This is certainly the most difficult of all functional problems to correct early, as the etiologies of open bite are multiple. At this point, there are several basic areas to explore in early correction of open bite: 1) Evaluate airway for possible tonsillectomy and/or adenoidectomy; 2) Orthopedically expand and rotate the maxillae to improve tongue space, increase vertical height to the nasal complex, and change inclination of the maxillae, especially in severe Class II malocclusions; 3) Evaluate allergy symptoms; 4) Early alleviation of severe anterior crowding to allow normal incisor eruption; 5) Evaluate tongue size, posture, and tongue thrusting pattern.

In cases where the open bite is not excessively severe, extender appliances (Hilgers) on an upper Hawley retainer to create incisor proprioception can be useful.

4. Excessive range of function (Fig. 10).

A. Clinical evaluation: Extreme maxillary prognathism causes the mandible to "reach" forward in order to create a "comfort" centric occlusion. These cases are referred to as "super Class II" malocclusions, as the mandible must reach forward to gain even a Class II molar relationship (Fig.11). Clinically, severe Class II malocclusion in which the mandible can be nudged gently back into centric relation and, upon closure, shows a more severe maxillomandibular dental relationship, is evidence of abnormal range of function.

B. Laminagraphic evaluation: Upon centric occlusion, the condyles will be forward in the fossa, downward and forward on the eminence, and will quite often reveal flattening of the anterosuperior surface of the condyle. Excessive joint space superior and distal to the condyles will be evidenced and, frequently, an upward/backward bend to the neck and the condyles will be seen.

C. Resultant growth changes: Pressure atrophy and sclerotic changes at the antero-superior surface of the condyles enhances the upward/backward growth and produces a more dolichofacial type of growth experience.

D. Timing and method of treatment: Although it is not critical that the entire Class II malocclusion be corrected, it is important that the maxillae and/or teeth be moved distally enough to allow the mandible to close without bringing the condyles downward and forward on the eminence. It is not unusual, following initial headgear therapy, to be able to cephalometrically measure a distal movement of the maxillae without appreciable correction of the Class II molar relation. This can be the result of a distal movement of the mandible, as the condyles drop back into the fossae. This may be the most important functional change which occurs with headgear therapy (Fig. 12).

5. Distal displacement (Fig. 13).

A. Clinical evaluation: The true distal displacement, in which the condyle is located in the posterior aspect of the temporomandibular joint, is quite commonly caused by a vertical inclination of the upper and lower incisor teeth, especially evidenced in Class II Division II malocclusion. Although it is possible for distal displacement to exist due to the inclines of the functioning buccal occlusion, incisal interferences are usually the culprits. These are typically the first functional problems to demonstrate pain in the temporomandibular joint complex and it is possible to have

crepitation, tinnitus, and early loss of mobility in a relatively young child.

B. Laminagraphic evaluation: The condyles are seated distally in the fossae with excessive space anterior and superior to the condyles. The posterior portion of the condyles is often seen to abut the tympanic plates and petrotympanic fissure of the temporal bone. Usually no irregularities in the condyles are evidenced (Fig. 14).

C. Resultant growth changes: Since there is no interference with the antero-superior portion of the condyles, these cases most often demonstrate normal growth turgor in the condyles. It is felt by some that it is the lack of normal articulatory pressure at the antero-superior portions of the condyles that enhances the brachyfacial aspect of these particular cases.

D. Timing of treatment: As the distal displacement is often caused by the vertical eruptive pattern of the upper and lower incisors, clinical factors which cause this eruptive pose should be avoided. Early removal of deciduous cuspids in the deep bite, brachyfacial type cases will free the anterior teeth to move in a lingual direction. This will further deepen the bite and the incisal trauma will slowly seat the condyles distally in the fossae. When early removal of deciduous cuspids is necessitated by extreme crowding, it is suggested that a lower lingual arch be placed to prevent excessive linguoversion of both the upper and lower incisor teeth. When a vertical inclination of the incisors already exists, early advancement of the upper incisors to create overjet often will allow the protracting musculature of the mandible to react, dominate, and free the condyles of the distal displacement. Overclosure of the mandible, with excessive freeway space, will also allow the condyle to seat distally in the fossa. Long-term, gentle, Class II elastics which help protract the mandible, as well as allow extrusion of the posterior buccal segments, are most helpful in correction of distal displacement. Where the extreme brachyfacial type exists, avoidance of extraction is important to assure proper vertical support in the buccal segment (Fig. 15).

6. Loss of posterior support superior displacement (Fig. 16).

A. Clinical evaluation: In cases where there are numerous congenitally missing or extracted posterior teeth, it is not unusual for the remaining posterior teeth to tip mesially as the vertical pull of musculature overrides the posterior support which holds the jaws apart. The result is a superior and distal movement of the condyles and, as in distal displacements, there can be an early onset of pain. Although this functional problem is seldom seen in the mixed dentition, ankylosis of numerous deciduous teeth and/or numerous congenitally missing teeth can create superior displacement. Superior displacement is most commonly seen, however, in the adult patient where anterior teeth have been retained, posterior teeth have been extracted, and proper vertical support in the buccal segments has not been maintained. Superior displacements are also seen in open bite cases where only a posterior occlusion exists. The condyles are seated superiorly in the fossae as the mandible pivots off of the limited posterior contacts.

B. Laminagraphic evaluation: The superior portion of the condyles seat near the apex of the fossae and excessive space is seen mesial to the condyle.

C. Resultant growth changes: As in the posterior displacements, there do not appear to be any early signs of growth alteration due to superior displacement.

D. Timing and method of treatment: Since the superior displacement can be caused by loss of posterior support, early removal of carious deciduous teeth without proper vertical support can be influential in creating this abnormal position to the condyles. When a stronger muscular pattern exists, and numerous deciduous teeth must, by necessity, be removed, replacement of these teeth in a retainer is important. The overclosure syndrome can take some time to develop and it is quite difficult to restore once the posterior vertical dimension has been diminished and the retained anterior teeth have adapted to the abnormal positions of the condyles.

7. Finger sucking /Lip sucking/Tongue thrust

A. Clinical evaluation: An open bite syndrome that is commonly initiated by the finger, aggravated by the lip, and maintained by the tongue can be considered a functional problem in that these habits may cause the development of, or accentuate, an open bite. It is not unusual for youngsters to suck on digits up to five or six years of age. However, when the permanent incisors start to erupt, deformation of the anterior alveolar process with dental protrusion and open bite can occur. Once the open bite occurs, the tongue and lip oppose during the act of swallowing, aggravating and continuing the open bite pattern.

B . Laminagraphic evaluation: Same as open bite.

C. Resultant growth changes: Same as open bite.

D. Timing and method of treatment: The approach toward the functional muscular problem should begin as a conservative suggestion to the child that the activity should be ceased. If the child is unable to control the habit pattern, expansion/thumb appliances should be placed when the upper and lower incisors and first molars are erupting. Due to the fact that these habit problems often cause constriction and posterior crossbite, expansion appliances should be incorporated at the same time the digit habit is being alleviated.

8. Breathing and airway problems (Fig. 17).

A. Clinical evaluation: When it is observed at initial examination that the child breathes through his mouth, a close evaluation of airway deficiency should be made. The parent will quite often attest to the fact that the child is a mouth breather and, when a hand is placed over the oral cavity, these children may have a difficult time breathing through the nasal passageway. Concomitant allergies and facial characteristics (allergic shiner, allergic salute) as well as large tonsillar and adenoid masses indicate the tendency for mouth breathing.

B. Laminagraphic evaluation: Usually the same as with open bite.

C. Resultant growth changes: Because the tongue is held low in the oral cavity to increase air

uptake, these cases are prone to maxillary collapse and crossbite. While holding the tongue low and the mouth open, the condyles are cantilevered down on the eminence, allowing the suprahyoid musculature to dominate, holding the chin down and back. This action creates wear on the upward/forward portion of the condyle and, again, allows upward/backward growth to dominate. Dominant upward/backward growth allows for a more receded chin posture in the face, worsening the open bite, and accentuating the functional muscular aberration.

D. Timing and method of treatment: Although the oral and nasal passages increase in size as the child grows, and tonsils and adenoids atrophy with age, long-term breathing problems that create open bite and potentially affect condylar growth, should be evaluated at an early age. It is not unusual to suggest tonsillectomy and/or adenoidectomy, allergy evaluation, and early orthodontic therapy to increase the size of the nasal airway.

9. True Class III Growth Patterns

A. Clinical evaluation: True Class III growth patterns represent the epitome in functional problems. They quite often exhibit a number of the functional aberrations previously mentioned as well as a genetic propensity for extreme upward/backward condylar growth, increasing the overall effective length of the mandible. This,, in conjunction with maxillary deficiency, can be mistaken for the simple anterior crossbite or vice versa. When true Class III is suspected, a family history as well as early cephalometric evaluation is warranted. Several cephalometric measurements (see JCO March 1977) can be utilized to evaluate the possibility that a Class III growth pattern exists.

B. Laminagraphic evaluation: When the mandibular teeth have bypassed the maxillary incisors, the condyles are often downward and forward on the eminence, with excessive space superior and distal to the condyles in the fossae. A long, thin condylar neck and long, thin ramus is often noted. Where the lower incisors are locked beneath the upper incisors or the patient physically restrains the mandible, distal displacement may be noted in the true Class III.

C. Resultant growth changes: The true Class III has an inherent tendency for functional displacement and genetic overgrowth.

D. Timing and method of treatment: When the true Class III growth pattern is detected early, it is usual to treat only the maxillary deficiency. Quite often early dental treatment of true Class III's results in linguoversion of the lower incisors and proversion of the upper incisors, which can make successful surgery at a later time difficult without retreatment. Relatively few true Class III's lend themselves to purely orthodontic treatment alone. Maxillary expansion and advancement, in an attempt to reduce maxillary deficiency, is the usual treatment of choice.

Resolve Arch Length Discrepancy

Arch length gain in the lower arch occurs three ways. Each should be explained in detail, as they are the foundations upon which long-term esthetics, stability, and function are accomplished. The first method, and probably the most difficult to comprehend, is that of lateral expansion of the lower

buccal segments. The second method is advancement of lower incisors. The third is an uprighting or distal movement of the lower molars, while maintaining deciduous spacing where it exists.

1. Lateral expansion of the lower buccal segments

Many cases, especially those of a Class II nature, demonstrate the possibility for arch length gain by lateral expansion of the lower buccal segments. It should be noted that this is a functional type of expansion, which proceeds in a slow, meticulous manner. The arch length gained through the natural expansive response in the lower arch is created by muscle and, as such, is extremely stable. This expansion occurs as the upper arch form is changed to bring the maxillary teeth and alveolar process into normal axial inclinations. As the upper arch is expanded and moved distally (and held in its expanded form for a long period of time), the lower arch responds, through muscular adaptation and function, reciprocally to expand. The lower arch also demonstrates a change in axial inclination that can begin at the deciduous canines and extend through the permanent molars.

Primarily, this functional expansion in the lower arch is dependent upon the feasibility of expansion in the upper arch. This, in turn, is dependent upon the original axial inclination and arch form existent in the malocclusion. Upper arch form changes, when indicated, occur quickly mainly by alveolar warping. In situations where the upper first molars and deciduous buccal segment are inclined lingually, (i.e., demonstrate a reverse curve of Monson), it is desirable to expand the upper arch by means of an outward tipping of the upper buccal segment as the alveolar process is bent or warped out into a more normal inclination. This should be distinguished from true maxillary deficiency where the upper buccal segments have good axial inclination but there is a generalized narrowness to the maxillary vault. (Fig. 18).

The arch form changes, expansive changes, and axial inclination changes that occur in the lower arch are merely a positive by-product of like changes in the upper arch. Although the reciprocal response in the lower arch occurs with many approaches, they are planned for and incorporated into early treatment procedures in the Bioprogressive Therapy (Fig. 19). It should also be noted that since the reciprocal expansion in the lower arch occurs over a prolonged period of time, the arch form and axial inclination changes of the upper arch should be manifested as rapidly as possible to allow for the long-term responses to occur in the lower arch (Fig. 20).

A. Expansion primarily by change in axial inclination: The appliance used to change arch form in most cases is the quad-helix or W expansion appliance (Ricketts). It is fabricated from .040" blue Elgiloy wire and is bent with a heavy bird beak plier. The lingual arm of the appliance extends to the deciduous cuspid and is either soldered to the upper first molar (or bent to fit into a lingual sheath). The posterior helix is beveled slightly to lay against the palatal vault and is as close to the upper molar as possible to prevent impingement on the palatopharyngeus muscle. The anterior helices are brought as far forward as possible and the anterior horizontal arm should generally sit over the incisive papilla, slightly lingual to the upper incisors to allow for intraoral activations. The anterior segment of the W expansion should be as wide as possible so that the appliance is maintained away from the swallowing position of the tongue. This will help avoid tissue

impingement of the appliance on the palate or tongue and can prevent an unwanted tongue thrust created by placement of sections of the appliance in the tongue space. All of the helices should roll to the top and should be tightly wound to increase their mechanical efficiency (Fig. 21).

In Class II cases, where most of the arch form change should occur in the anterior portion of the buccal segments, it is ideal to place the appliance with accentuated molar rotation and anterior expansion. As the upper molars are expanded approximately 1cm per side, the anterior segments are expanded approximately 3cm overall (Fig. 22). The appliance should take the characteristic form of a "W" prior to initial placement. It would be ideal to have the appliance completely work itself out without intraoral activation if possible.

When increased activation is necessary, intraoral adjustments of the W appliance can be achieved with a three-prong plier or by a set of angulated three-prong pliers made especially for intraoral activation. The first month of appliance therapy should occur by initial activation, but as changes need to occur, intraoral activations are quite efficient at producing the response. When an intraoral bend is made in the anterior segment (Fig. 23) to increase the amount of overall expansion, a reciprocal bend must be made in the posterior section in order to compensate for the tendency for mesial rotation of the upper molars. Therefore, three intraoral adjustment bends are usually made at each activation. Also, it will be noted that, as the appliance works itself out, the lingual portion has a tendency to drop away from the roof of the mouth and must be bent back palatally in order to prevent tissue impingement on the tongue.

Where extreme mesial rotation of the upper molars exists, it is beneficial to allow for distal molar rotation to occur prior to anterior buccal segment expansion. This is accomplished by keeping the lingual arms away from the deciduous buccal segments. As the upper molars rotate distally, the lingual arm will swing across to pick up the buccal segments and start to expand these teeth. Following expansion with the W appliance, the upper molars should be rotated distally, the upper buccal segments expanded, a more normal upper arch form created, and increased space for erupting upper central and lateral incisor teeth is evidenced. On frontal headfilm some midpalatal dysjunction will also be noted. Typically, the upper buccal segments are expanded to an end-on-end relationship (i.e., lingual cusps of upper teeth over the buccal cusps of lower teeth). If the upper molars are inadvertently expanded into complete buccoversion, the appliance should be activated in a reverse fashion to bring the upper molars back to their ideal expansion position.

The overall expansive process should take not more than three months. Although this is long enough to allow for arch form changes, axial inclination changes, and spacing to occur in the upper arch, it is not adequate time to allow for the reciprocal responses that we expect to occur in the lower arch. The W expansion appliance is removed by sectioning out the helical portion of the appliance while leaving the lingual arms that extend from the upper molars to the deciduous cuspids. When a headgear is to be placed the same day, this will allow for removal of the active portion of the appliance while maintaining the expansion form for a longer period of time through the headgear and lingual arm of the appliance. It is felt by the authors that it is long-term functional expansion of at least a year or more that allows for the most stable and demonstrable changes to

occur in the lower arch.

As mentioned previously, the arch form and axial inclination changes that occur with the W expansion also occur in long-term headgear therapy with an expanded inner bow, which the authors consider one of the most efficient and effective expansive approaches.

B. Expansion by midpalatal dysjunction: Although true maxillary deficiency cannot be discussed in full in this article, where the axial inclination of the upper buccal segments is more ideal and yet crossbite exists, palatally borne appliances are typically used to enhance midpalatal dysjunction. A Haas-type or modified Nance appliance is used to gain these changes.

Overexpansion of the maxillae is necessary, as the palatal vaults tip buccally and must be allowed to upright to create normal axial inclinations as well as ensure stability in the expansive process.

2. Advancement or forward movement of the lower incisors

When the visual treatment objectives and physiologic factors warrant (i.e., symphysis size, shape, and form; muscle position; esthetic considerations), retruded lower incisors can be gently intruded and advanced to reach a more favorable esthetic relationship to the APo line. Most often, this type of forward movement of the lower incisors is attempted in the brachyfacial type case, where bite opening should partially occur by virtue of incisor intrusion, as well as change in axial inclination of these teeth. The shape of the symphysis (usually wider anteroposteriorly) typically allows for the downward/forward movement of the lower incisor teeth. Each 1mm of forward movement of the lower incisors will yield 2mm of arch length gain (Steiner). Usually, selection of the type of case that allows for intrusion and advancement of the lower incisors is dictated by the nature of the problem and the integrity of the alveolar process anterior to the lower incisor teeth. Where there is a thin cephalometric fadeout of bone anterior to the lower incisors, cortical ribbing and remodeling resorption around these teeth, and tissue problems, the possibility of forward movement of the lower incisors is guarded.

3. Uprighting and/or distal movement of the lower molars

With routine use of the utility arch in deep bite situations, the simple uprighting of the lower molars will allow the roots of these teeth to come forward while yielding space in the arch. When mesial tipping of the lower molars is evident, 2mm per side of arch length is gained by this simple uprighting effect. Further distal movement or intrusion of the lower molars can create problems with the erupting second molars. It is usually ideal to stabilize the lower molar once it has reached a normal position upright at 5° to the occlusal plane.

Correct Vertical Problems-- Correct Overjet Problems

Once functional problems have begun to be resolved and needed arch form changes incorporated, correction of the orthodontic/orthopedic problem is initiated. While the authors feel

that there should be an overriding reason for treating overbite/overjet problems, other than those specific to arch length and functional problems, several distinct approaches to the resolution of nonextraction cases in the early mixed dentition will be presented.

Although it is impossible to demonstrate treatment for every type of case which exists, essentially six basic variations of early treatment mechanics will illustrate the basic approaches available in first phase nonextraction therapy.

1. Orthopedic problems.

In cases where good alignment of the lower arch exists, but there is a Class II malocclusion due to maxillary protrusion, a headgear alone (either cervical or combination) is utilized to reduce convexity by rotating the maxilla downward and backward. It should be noted that overjet reduction by virtue of maxillary orthopedic rotation should occur only if overjet exists and there will not be ensuing trauma between the upper and lower incisors as the maxilla is moved distally.

2. Orthopedic problems with lower arch therapy.

When the maxilla is in protrusion, but the lower incisors and molars are either in deep bite or need advancement (or retraction), the upper headgear is used in combination with a lower utility arch. The utility arch acts primarily to upright the lower molars and intrude the lower incisors, depending upon their ideal final location. The intrusion of the lower incisors allows the maxilla to be rotated distally without incisal interferences, as well as creating the reverse response in the lower arch which allows many early treatment cases to be finished with Class II elastics.

3. Orthopedic problems-- Enhanced maxillary movement.

In cases where reduction of maxillary protrusion by virtue of orthopedic rotation of the maxilla is required, but the growth pattern does not suggest use of a cervical headgear, the upper first molars and incisors are banded/bonded along with placement of a combination headgear. The directional headgear (one whose forces are directed above the center of resistance of the upper molars) can be utilized either on a full-time or part-time basis. The upper incisor bands/brackets are often utilized to maintain integrity of the upper arch without severe distal movement of the upper molars in orthopedic reduction.

4. Combination orthopedic/orthodontic problems.

When a combination of orthopedic and orthodontic movements is required to correct both the skeletal and the tooth relationships, cases are initially started with a headgear and a lower utility arch. The utility arch acts to level the deep curve of Spee by intrusion of the incisors while uprighting the molars, and allows for anchorage to finish Class II correction with elastics. Following orthopedic rotation of the maxilla to its desired position, the upper incisors are banded and an upper utility arch placed. Class II elastics are then worn from the lower utility arch to the upper utility arch to allow for the final orthodontic movement of the dentition into an overtreated Class I situation.

5. Orthopedic problems with incisor interferences.

Where a Class II, division II type of upper incisor inclination is present, and maxillary protrusion exists, it is desirable to advance the upper incisors prior to orthopedic reduction with the headgear. This initial movement creates overjet, helping to avoid traumatic occlusion between the upper and lower incisors as the maxillae are being compressed distally. The upper incisors and molars are banded/bonded and the upper incisors advanced with a utility arch, then the wire is removed. A headgear is initiated to begin orthopedic reduction of the maxilla and, after bonding, a lower utility arch is placed to further open the bite as the maxilla is being moved distally. Later, depending upon the position of the upper and lower incisor teeth, Class II elastics are utilized to facilitate the Class II correction.

6. Orthodontic problems.

When the maxillo-mandibular skeletal relationship is essentially good, and yet a deep bite and Class II molar relationship exists, it is ideal to treat these cases by movement of the teeth. The upper incisors and molars are banded/bonded and a utility arch placed to advance and intrude the upper incisors, creating a normal axial inclination of these teeth. After sufficient overjet occurs, the lower incisors and molars are banded/bonded to intrude and advance the lower arch. Class II elastics are utilized immediately to correct the entire Class II molar relation (Fig. 25).

Retention Procedures

From the management standpoint, all patients are told that there will be a second phase of therapy to finish the details that began with the first stage of treatment. In light of this fact, it is important to evaluate exactly what we wish to retain in the first phase of therapy. It is taxing to the patient, to say the least, to undergo six or seven years of active orthodontic therapy. Early treatment requires more discipline on the part of the orthodontist than any other phase of therapy because it places a premium on efficiency. The orthodontist must make numerous decisions as to case selection, treatment timing, length of treatment, retention characteristics, the need for the second phase of treatment, and socioeconomic factors. In addition to the critical aspect of correct case selection, a careful explanation must be given to the patient as to the reasons for his or her selection for early treatment procedures. It can be easily demonstrated that fees for two-phase therapy, considering the amount of time and expense involved, should be, overall, one-third to one-half higher than for single phase therapy.

Some thought should be given to the ability of the child to properly retain a first phase therapy without overtaxing his or her cooperation. Remember, decisions concerning an overall approach to early therapy should be made in light of the broad spectrum of cases while allowing for individual variations. One might wish to completely retain and attempt to hold all of the original corrections in one case, while another may require only a modicum of retention, anticipating long-term therapy later. It is easier to be strong about retaining a case that should have treatment in the first place rather than one whose original treatment was, at the very best, questionable. This places a tremendous importance on case selection and proper case management to reach a known objective.

Although headgear can be continued over protracted periods of time to maintain molar

relationship and orthopedic reduction, thereby reducing physiologic rebound, in many cases such long-term cooperation is difficult to achieve.

The retainer that is most commonly used after first phase therapy is the Hawley retainer with an inclined plane. The Hawley bow acts to hold upper incisor alignment and position, while the inclined plane holds the lower incisor alignment both from the labial (by the upper incisors) and the lingual (by the incline plane). The labial bow is fabricated from .028" blue Elgiloy wire and the vertical loop is short and is situated between the upper lateral incisor and the deciduous canine as this is the only open contact in the mixed dentition. Ball clasps are placed to the upper molars and any space created between the upper first molar and deciduous second molar is maintained with an acrylic bridge (Fig. 26).

At times, when extreme advancement of the lower incisors has been achieved and arch length is critical, a lower lingual arch is placed. The patients are instructed to wear the upper Hawley retainer full time during the first year after treatment and usually are instructed to wear the retainer at night time during the second and/or third year of retention therapy. Only in very selected cases are the headgears maintained for extremely long periods of time, thus minimizing the amount of therapy that the majority of patients might receive.

Fig. 1

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Fig. 3

Fig. 4

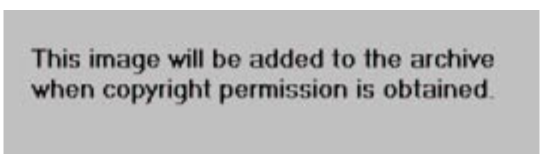

Fig. 4

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Fig. 9

Fig. 10

Fig. 10 Excessive Range of Function. Also note flattening of the upward/forward portion of the condyle (A) and a distal bend to the condyle (B) in this 5-year-old male.

Fig. 11

Fig. 11 Laminagraphic section on a 5-year-old male with extreme Class II malocclusion. Note the condyle is forward in the fossa and there is flattening of the upward/forward portion of the condyle. The child had to reach forward to gain the Class II molar relationship in the deciduous dentition.

Fig. 12

Fig. 12

Fig. 13

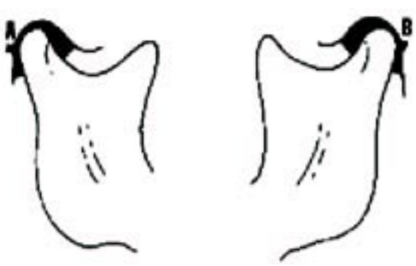

Fig. 13 Distal Displacement: Both condyles (A and B) in this 52-year-old woman are seated distally in the fossae, impinging upon the tympanic plates and petrotympanic fissure. Normal integrity to the condyles is seen.

Fig. 14

Fig. 14 Laminagraphic section demonstrates a straight distal displacement in a Class II Division II malocclusion. The condyle is seated distally in the fossa as guided by the vertical inclination of the incisors and inclined planes of the buccal occlusion.

Fig. 15

Fig. 15 Serial extractions in the Class II nonextraction brachyfacial growth pattern. The lower incisors were not supported forward allowing for linguoversion of the upper incisors and distal displacement in this 12-year-old female. Early onset of pain was evidenced .

Fig. 16

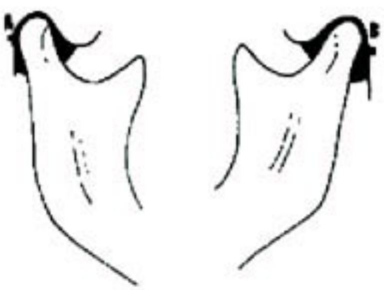

Fig. 16 Superior Displacement. Both condyles (A and B) in this 37-year-old edentulous male are seated superiorly in the fossae, away from a normal articulation with the eminence.

Fig. 17

Fig. 17 Large tonsillar (a) and adenoid masses (b) caused the mandible to cantilever downward and backward In the typical mouthbreathing posture. The condyles are forward on the eminence, enhancing their upward/backward growth.

Fig. 18

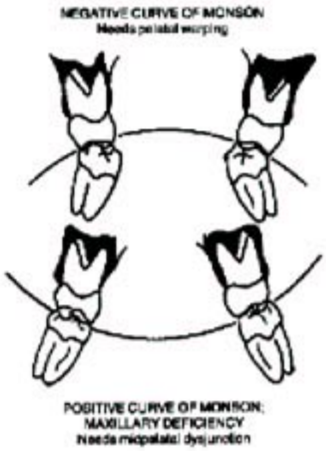

Fig. 18 Lingual tipping of upper molar (above) must be distinguished from true maxillary deficiency (below).

Fig. 19

Fig. 19 Lingually inclined upper buccal segments in Class II Division I malocclusion confining arch widths in the lower arch.

Fig. 20

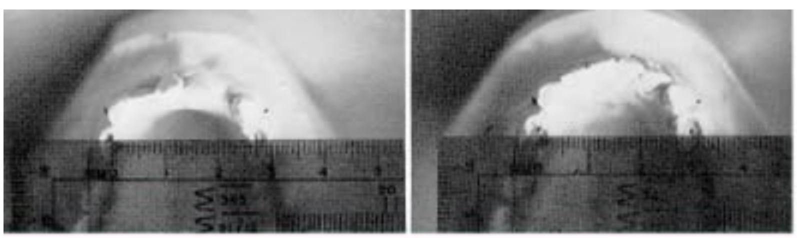

Fig. 20 Functional arch width increase in lower arch showing upper arch expansion. Note sagittal increase from 27mm to 30mm in first deciduous molars. Similar arch width increases occurred in the other posterior teeth.

Fig. 21

Fig. 21

Fig. 22

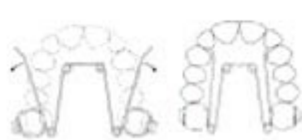

Fig. 22

Fig. 23

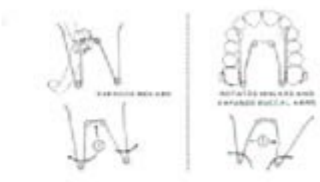

Fig. 23 Intraoral activation of quad-helix appliance.

Fig. 24

Fig. 24

Fig. 25

Fig. 25 Upper and lower utility arch therapy in Class II Division I deep bite case with severe maxillary protrusion.

Fig. 26

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Figures

Fig. 1 Early investigation led researchers to believe that normal growth of the condyle was in an upward/backward direction. Superimposition on the mandibular plane and either menton or pogonion revealed an upward and slightly backward eruption of the dentition. Note that it was assumed that the mandibular border was a stable reference point.

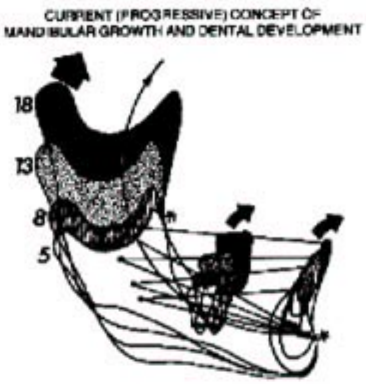

Fig. 2 Recent investigative studies demonstrated that, in normal growth, the condyle is growing in an upward/forward direction with major growth turgor at the superior aspect of the ramus. Stable reference points at the anterior coronoid slope and suprapogonion reveal that the mandibular border is resorbing and eruption of the dentition is in an upward/forward direction. This figure reveals superimposed mandibular growth from age 5 to 18 years.

Fig. 3 Although growth of the mandible at different ages is on the same arc (A), the arc continues to open (B) as the chin grows down the facial axis (C). Each identical arc is seen to cross at a pivotal point near the sigmoid notch (D).

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Fig. 4 The mean condyle location in "100 Normal Cases". Note the well-centered position and smooth articular surfaces. A. condyle - eminence, B. condyle - fossa, C. condyle - meatus. (From Ricketts, Am. J. Orthod. June 1955)

Fig. 5 20º Oblique laminagraphic x-ray demonstrates ideal condyle-to-eminence and condyle-to-fossa relation.

Fig. 6 Method of submento-vertex analysis for determination of individual condylar inclinations and widths. (As suggested by Williamson and Wilson, Am. J. Orthod. August 1976.) A. Transporionic axis. B. Condylar axis; note the different medial-lateral angulations of the condyle from side to side in this same patient. C. Distances to the mid-sagittal plane.

Fig. 7 Cross-mouth interference. The translatory side (A) exhibits either normal condylar location or distal displacement. The moving side condyle (B) is out of the fossa, down on the eminenceand, in this 12-year-old, flat-tening of the condyle is evident.

Fig. 8 Anterior crossbite. Both condyles (A and B) forward on the eminence with excessive wear in this 32-year-old woman. Open bite may have normal condylar location in the fossa.

Fig. 9 In this 27-year-old male, there was a breakdown in the integrity of the condyles.

Fig. 10 Excessive Range of Function. Also note flattening of the upward/forward portion of the condyle (A) and a distal bend to the condyle (B) in this 5-year-old male.

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Fig. 12 A. Pretreatment laminagraph on a 7-year-old; severe Class II malocclusion with anterior open bite. Note the end-on-end molar relationship and forward position of the condyle. The condyle is also out of the fossa and bent distally. B. After ten months of combination headgear therapy, the molar relationship is still end-on-end, Class II. Note that the condyle has dropped back in the fossa and a more normal morphology and contour is evidenced.

Fig. 13 Distal Displacement: Both condyles (A and B) in this 52-year-old woman are seated distally in the fossae, impinging upon the tympanic plates and petrotympanic fissure. Normal integrity to the condyles is seen.

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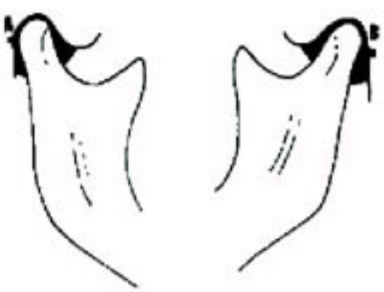

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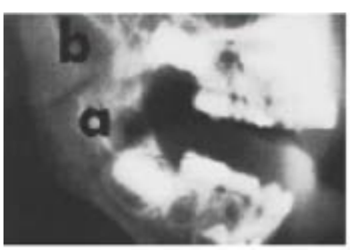

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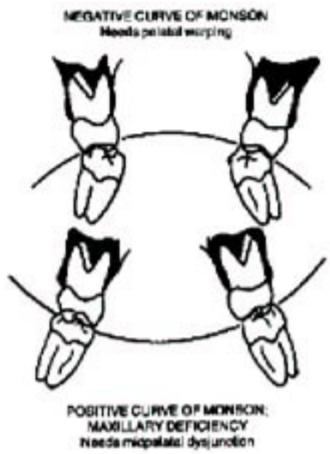

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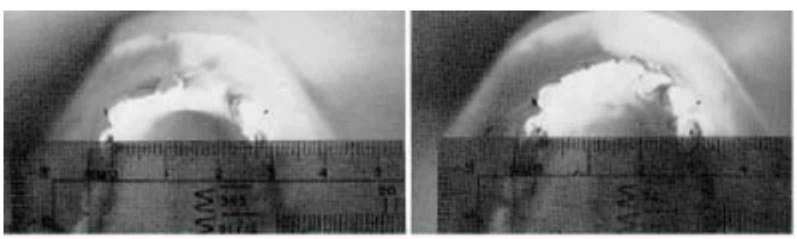

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Fig. 21 The quad-helix or W expansion appliance (Ricketts).

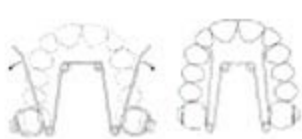
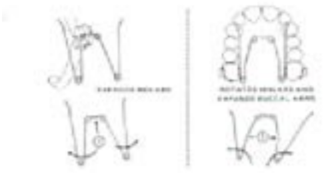


Fig. 22 Initial activation of quad-helix appliance for insertion.



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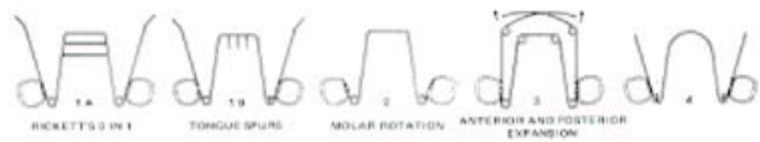

Fig. 24 Modifications of the quad-helix appliance.

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