1.

Why Orthodontics?

Why should the general practitioner be interested in orthodontics?

Orthodontics is a very rewarding aspect of dentistry. Unlike other fields of dentistry, the patient can visualize the results and is generally more appreciative of the clinician's accomplishments. There is no magic to orthodontics; in fact, moving a tooth is one of the easiest procedures to accomplish in dentistry. There is no reason why a general dentist cannot incorporate orthodontics into his or her practice as other specialties are incorporated. All it takes is a thorough understanding of the concepts of diagnosis, treatment planning and treatment.

One problem regarding orthodontic education in the dental curriculum is that it takes so long to treat a typical case, and therefore the results are not immediate. The contemporary dentist, however, has an advantage over his or her "older" counterparts. In the educational process of today, dental schools are "forced" into introducing the dental student to the clinical principles of orthodontics due to the curriculum requirements placed on them by the Council of Accreditation of the American Dental Association.

Caries- Free Society?

A study performed at the Great Lakes Naval Center in the 1940's showed that less than 1 out of 1,000 18-year old patients was caries-free. (That's almost 0%!) A more recent study by the National Institute of Dental Research found that approximately 50% of the 18-year old patients were caries-free. It is obvious that because of fluoridation and preventive dentistry, fewer patients have the amount of caries that were seen just a short time ago.

A study done by the NIDR in the early 1960's showed that more than 20% of patients in the 35-60 year old range were edentulous. A similar study in 1985-86 showed only 4% of that group were edentulous. Again, because of fluoridation and preventive dentistry, fewer patients are losing their teeth.

Periodontal Disease

More patients are dying later in life, and with all their teeth, than ever before. As stated in a recent study: "....periodontal disease may fall as dramatically as has the prevalence of dental caries." There is a concerted effort today among periodontal researchers to develop chemotherapeutic agents to slow or arrest periodontitis, and even a future vaccine to eliminate it entirely. Nonetheless, present tartar control rinses and better periodontal care will more than likely eliminate periodontal disease as a cause of severe tooth loss in today's dental practices.

"Orthodentist"–Clinician of the Future?

There is a very important role for the general dentist in orthodontic practice. The general practitioner/"orthodentist" should be able to perform an orthodontic diagnosis on all patients in his or her practice. Diagnosis and treatment planning are the "bread and butter" of orthodontics, because they answer most of the questions required of the dentist to understand the complexities of a malocclusion.

What are these important questions that should be answered by the "orthodentist" of the future?

Why? . . . Is the treatment needed, and for what purpose?

There are certain "transient" malocclusions that occur during various stages of dental development that are treated by "nature." In other words, these are "age-related" problems in which a malocclusion is "normal." Examples of these will be explained later in the text, and will be differentiated from "incipient" malocclusions, which occur at an early age but need clinical intervention. This is why "differential diagnosis" is the key to any orthodontic treatment plan.

When? . . . At what age should the treatment commence?

Not long ago, it was common practice to allow a child to develop his or her permanent dentition prior to the onset of orthodontic treatment. This mistake caused the clinicians of the past to rely on extraction of permanent teeth because growth was not a factor at this stage of development. Knowing what cases can be treated at an earlier age has allowed the clinician to "work" with growth and to aid in proper dental development.

What? . . . Is the problem skeletal or dental?

Oftentimes, a clinician will rely on a set of dental casts in order to determine the severity of a malocclusion. It will be shown that radiographic diagnosis is much more reliable than stone study models to determine the complexities of a malocclusion. Therefore, it is incumbent on the general dentist to determine the type of problem which the patient presents, and often this will determine whether the case is "easy," or one that needs to be referred to an orthodontic specialist.

Where? . . . Which direction should the teeth be moved?

An axiom in orthodontics used to be "never expand a dental arch." Another one was "never advance incisor teeth." These and other "myths" have long been discarded. However, a clinician must know his or her limitations as to the amount of expansion or incisor advancement a particular case can withstand and still remain stable after orthodontic treatment. Proper diagnosis and treatment planning provide the answers to the question, "Which direction should the teeth be moved?"

"How?" . . . Which appliance should be used?

Unfortunately, most general dentists try to answer this question first, and they "put the cart before the horse." In other words, the prior questions of why? when? what? and where? should be answered first before an attempt is made to design an orthodontic appliance. The immediate action to treat most likely comes from training received in dental school where a student reaches for his or her handpiece without much thought of differential diagnosis.

Differential Diagnosis

This is the process whereby the dentist determines the degree of difficulty of the orthodontic problem. The dentist then determines whether or not he or she has the ability to treat it; if it is too difficult, the patient should be referred to an orthodontic specialist. The best method to obtain a proper diagnosis, in any field of dentistry, is to have proper diagnostic records. Beside a detailed patient history and anatomically trimmed study models, the clinician requires the following radiographs for orthodontic diagnosis.

♦ **Children**

- **Panorex radiograph to determine dental development, present and missing permanent teeth;**
- **Posterior bite-wings to determine caries;**
- **Lateral cephalometric radiograph to determine anteroposterior and vertical skeletal discrepancies;**
- **Frontal (P-A) cephalometric radiograph if an asymmetry is present.**

♦□□□ **Adults**

- **Full mouth periapical and posterior bite wing radiographs to assess alveolar bone condition, root length, caries and other pathologic problems;**
- **Cephalometric radiographs if there are skeletal or asymmetric discrepancies.**

Patient Analysis Case Selection

Only with a thorough understanding of the concepts of orthodontic diagnosis and treatment planning can the general dentist perform a proper patient analysis and case selection, and then to determine if the patient needs treatment and who should treat it.

STAGES OF DENTAL DEVELOPMENT	ORTHODONTIC TREATMENT
Deciduous (2-6 yrs) ————	Preventive
Mixed (7-12 yrs) ————	Interceptive
Permanent (12+ yrs) ————	Corrective

A frequent question asked of an orthodontist is, "When should the clinician treat a malocclusion?" The author's usual answer to this question is, "Whenever the clinician diagnoses the problem." Although this may seem to be a sarcastic answer to some, the author's feeling is that often orthodontic problems go undetected leading to more complicated treatment "down the road." The general dentist is the "watch dog" of the dental profession, and should be able to detect all intraoral problems as soon as possible, treat those within his or her purview, and refer the more difficult treatment modalities to the specialist.

Another frequent question asked is, "When is the best age to perform routine orthodontic diagnosis on all patients?" The author's response to this question is, "As early as possible." As can be seen from the table above, preventive orthodontic care can only be accomplished in the deciduous dentition, between the ages of 2 and 6 years. Proper mesial and distal tooth restoration is important for the integrity of the dental arch, and the cessation of certain oral habits, such as thumb and finger sucking, should occur at this age to prevent dental and skeletal deformities from developing.

It is the author's opinion that every patient in the mixed dentition (ages 7-12 years) should have a thorough orthodontic diagnosis performed. This is the ideal age at which time certain dental and skeletal deformities can be intercepted with orthopedic and orthodontic appliances. The permanent teeth can be "guided" into the dental arch, and jaw growth can be "redirected" with the use of orthopedic appliances. The clinician can provide a great benefit to his or her patients by the use of interceptive techniques, allowing for ease of treatment and, in most cases, less costly therapy than allowing the malocclusion to develop into the adult dentition.

After the age of 12 years, most patients have all their permanent teeth, with the exception of their 3rd molars. Tooth guidance is impossible during the adult dentition, and more importantly, the major growth of the jaws has taken place by this age, and orthopedic appliance therapy cannot be performed effectively. Corrective orthodontic treatment is the only modality of choice for the clinician, and it usually requires fixed appliances and more complicated and costly treatment for the patient.

History of Orthodontics

In order to appreciate what has been achieved in any area of dentistry, it is important to see how we got there and who helped us. In 1901, orthodontics was established as the first specialty in dentistry. Dr. Edward H. Angle "the father" of orthodontics, had both an M.D. and a D.D.S. degree. Born in Minnesota, he moved to St. Louis, and

started the first specialty program in orthodontics (Angle School of Orthodontics). His final move was to Pasadena, Calif. where he established his school, and taught numerous orthodontists who formed many of our contemporary concepts of orthodontics. He started the American Association of Orthodontists, as well as the American Journal of Orthodontics. He died in 1930, and "The Angle Orthodontist" and "The Angle Society" were formed in his memory, a prestigious journal and orthodontic society that are still in existence.

In 1900, Dr. Angle wrote his first textbook. In it, he wrote about the classification of malocclusion, and orthopedic and orthodontic appliances that are still used today.

Purposes of Orthodontic Treatment

►↓ Esthetics

►↓ Interception

►↓ Preprosthetics

►↓ Preventive Periodontics

▶↓ **Procedural**

▶↓ **Prevention of Pathosis**

▶↓ **Correction of Speech Defects**

▶↓ **Facilitation of Surgery**

▶↓ **Esthetics**

Probably the greatest stimulus to seek orthodontic treatment is the unsightly appearance that is caused by malposed teeth. This is especially true when the esthetic appearance of the anterior region of the mouth is considered. Examples of these malocclusions are excessive flaring of the maxillary anterior teeth, diastema, anterior crossbites and anterior crowding.

Figure 1. Prolonged thumb sucking habit

▶**Interception**

The interception of an incipient developing malocclusion by elimination of certain local factors over which the dentist has control is one of the most important reasons for early intervention with some type of limited appliance therapy. A good example of this purpose of orthodontic treatment is the interception of a thumb sucking habit during the "mixed" dentition. (Figure 1)

Figure 2. Preprosthetic appliance

▶ **Preprosthetics**

Often when teeth are not replaced for some time after extraction, the drifting that occurs can present a restorative problem. Closing and opening of spaces and uprighting of abutment teeth are often necessary before a proper removable prosthetic appliance can be fabricated. (Figure 2) Also, when teeth are moved into correct alignment prior to the use of fixed prosthesis, it is not necessary to remove excessive amounts of tooth structure.

▶ **Preventive Periodontics**

Much orthodontic therapy today can be termed preventive periodontics. The periodontal reasons for orthodontic treatment are important for proper oral hygiene and for the overall health of the dental alveolar structures. Often, as the result of an arch-length deficiency, a mandibular incisor migrates into a position where the abnormal forces of occlusion are detrimental to the surrounding periodontal structures. (Figure 3)

Figure 3. Periodontically involved lower incisor

In the resent past, an emphasis has been placed on adult orthodontic treatment. The periodontal implications of treatment are even more important for adults. Granted, orthodontic treatment may very well prevent future periodontal problems, but it is incumbent on the clinician to make sure that the adult patient's periodontal condition is "under control" prior to orthodontic treatment. The axiom "orthodontic treatment is a pathologic process from which the tissues recover" is especially important for the adult patient. As will be explained further, tooth movement is not a physiologic process, and the healthier the alveolar and periodontal tissues, the more likely the patient will "recover" from orthodontic treatment. It is the author's contention that every adult patient should undergo a thorough periodontic evaluation prior to any attempt of tooth movement.

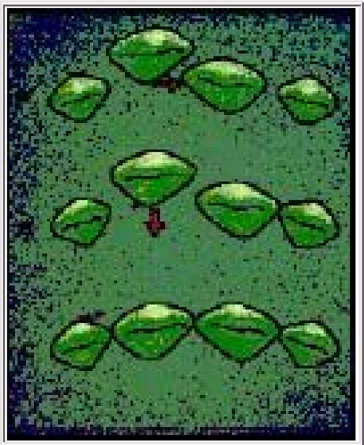

Figure 4. Procedural tooth movement

▶ **Procedural**

During the movement of a tooth, it may be necessary to shift adjacent teeth in order to gain sufficient space for the malposed or unerupted tooth. The creation of sufficient space for an unerupted or ectopically erupting maxillary or mandibular tooth is an example of this purpose of orthodontic treatment. (Figure 4)

▶ **Prevention of Pathosis**

In some instances of severe protrusion of the maxillary anterior teeth, it is extremely difficult for patients to close their lips without a great deal of muscle strain. (Figure 5) The lips become extremely dry, with a resultant irritation. In some cases, anterior teeth are protrusive and unprotected, and can easily be fractured during an accident. Also, the tongue can become irritated if teeth are lingually or palatally displaced.

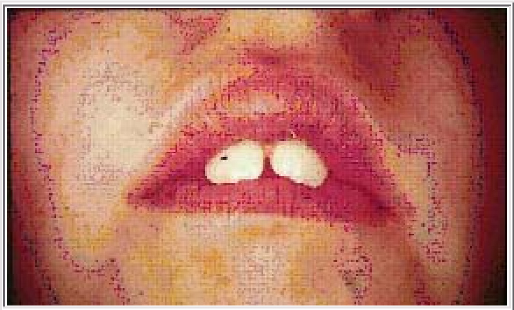

Figure 5. Protruding maxillary incisors

▶ **Correction of Speech Defects**

Certain malocclusions can cause defective pronunciation, especially of the sibilant sounds. The types of tooth malposition that can cause speech problems are anterior open bites, anterior crossbites, anterior tooth protrusion, interdental spacing, and interarch discrepancies. Because correct tongue position is often difficult to attain for proper speech and deglutition, correction by repositioning of the teeth makes it physically possible for the patient to pronounce the various sounds.

Figure 6. Facilitation of surgery

▶ **Facilitation of Surgery**

The orthodontist and the oral surgeon work cooperatively as a team in the correction of such disorders as severe mandibular prognathism and cases of micrognathia associated with certain skeletal dysplasias. (Figure 6) This "joint effort" by the two specialists should commence prior to the onset of any treatment. After a thorough diagnosis, a treatment plan is formulated, and various fixed appliances are utilized by the orthodontist for presurgical orthodontic manipulations. The orthodontic appliances also aid the oral surgeon during the process of maxillomandibular fixation.

Prerequisites for Treatment

Certain limitations may rule out many cases in which it would be desirable to change the position of teeth but in which it would not be safe or practical to use "minor" procedures.

- ▶↓ Adequate Space
- ▶↓ Elimination of Interferences
- ▶↓ Allowable Axial Inclination
- ▶↓ Correctable Etiologic Factors
- ▶↓ Favorable Periodontal and Periapical Prognosis
- ▶↓ Absence of Contraindications

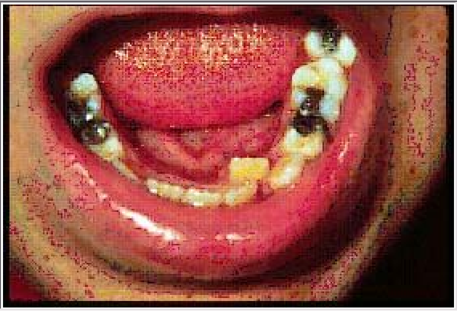

Figure 7. Lower anterior crowding

▶ Adequate Space

There must be adequate space between the adjacent teeth to permit entry of the tooth that is to be moved, or it must be possible to gain the necessary room. Certain hereditary factors causing the patient to have small jaws and/or unusually large teeth can produce severe crowding and cause to contraindicate the use of removable orthodontic appliances. In most cases, these hereditary factors cause an arch-length, tooth mass discrepancy. (Figure 7) It is incumbent for the dentist to thoroughly understand the process and concepts of jaw growth and development. If the clinician realizes that the patient has a severe skeletal problem, then he or she should make the proper referral to a specialist for comprehensive treatment.

Figure 8. Bite plate appliance

▶ Elimination of Interferences

It must be possible to eliminate occlusal interferences in all excursions of the mandible at all stages of the tooth's movement into the desired position. The occlusions of anterior crossbites and deep overbites (incisor vertical overlap) have a tendency to cause interferences during the course of active tooth movement, and these interferences must be removed. Occlusal adjustments can be performed by the clinician during therapy, or the use of a removable maxillary bite plate appliances can be utilized. (Figure 8)

Figure 9. Axial inclination of maxillary incisors

▶ **Allowable Axial Inclination**

Most minor tooth movement procedures produce a tipping action on the malposed teeth. The tooth to be moved must have such an axial inclination that the tipping forces used will not produce an unfavorable relationship. In other words, only "fixed" orthodontic appliances can cause the tooth to move "bodily," or in all planes of space. Therefore, prior to the use of removable appliances, the dentist must evaluate whether or not he for she can correct a malocclusion given the state of the labio-lingual or mesio-distal axial inclinations of the teeth. (Figure 9)

▶ **Correctable Etiologic Factors**

All etiologic factors causing the malocclusion must be correctable. Some of these factors are extremely difficult to eliminate, but their continued presence will prevent successful treatment or retention of the orthodontic problem. "Intrinsic" factors are considered internal, and these include heredity and congenital deformities. Some of these factors may or may not be correctable, and they may cause the general dentist problems during the course of orthodontic treatment. The earlier these intrinsic factors are diagnosed, the sooner the dentist can realize the severity of the patient's problems in order to make an educated referral to a specialist for orthodontic treatment.


Figure 10. Nasopharyngeal airway

On the other hand, "extrinsic" factors, as the word indicates, are external in nature, and are easier to control by the clinician after a proper diagnosis is made. Examples of these factors are prolonged intraoral habits such as thumb sucking, and mouth breathing. The latter may or may not be the result of a habit, but due to an internal problem such as hypertrophied nasopharyngeal adenoid tissue in a child. (Figure 10) It is important for the dentist to make this particular diagnosis, or perhaps refer the patient to an otolaryngologist for a medical review of any problem that exists.

▶ **Favorable Periodontal and Periapical Prognosis**

Periodontal and periapical prognosis of the tooth must be favorable. The periodontium must be healthy in order to have the proper tissue response required for tooth movement. Too much emphasis cannot be placed on what was mentioned earlier, namely, "Orthodontic treatment is a pathologic process from which the tissues recover." Scaling, root planning and curettage are done before orthodontics, whereas most periodontal surgical procedures should be performed after orthodontic treatment. Endotherapy should be

done before orthodontic therapy, as a vital tooth is necessary to prevent any possibility of root resorption during its movement.

- **Absence of Contraindications**

Systemic conditions that have oral manifestations must be ruled out prior to orthodontic tooth movement. Any factor that produces gingival enlargement can cause pressure that may force teeth to migrate. Systemic factors such as diabetes and patient reaction to certain medications can cause the intraoral tissues to hypertrophy, which would cause an impediment to tooth moving procedures. (Figure 11) A most important issue is good patient cooperation. Poor oral hygiene during the course of orthodontic treatment can also cause the gingival tissue to become irritated and often enlarged.

Figure 11. Hypertrophy of gingival tissues

Biomechanical Principles

Definition: "The application of the principles of mechanics to biologic systems." The topic of biomechanical principles cannot thoroughly be discussed in a few simple paragraphs. In fact, there have been several text books[1,2] written to adequately describe this most important aspect of orthodontic therapy. However, it is important for the clinician to realize that "the tooth does not know what appliance is being used on it." During the use of a removable orthodontic appliance, the pressure applied to a tooth by the round wire of the appliance is at one point of the tooth. As mentioned previously, it is not possible to produce "bodily" tooth movement–only tipping (labiolingual, buccolingual, and mesiodistal). Fixed appliances, on the other hand, can cause a tooth to move in all planes of space. Depending on the fixed appliance used, such sophisticated procedures as intrusion, rotation, extrusion and torque can all be accomplished. Again, numerous texts[3,4] have been written on the subject of fixed orthodontic appliances in order for the general dentist to get a thorough understanding and respect for this method of therapy.

Force Systems		
grams	forces	tooth movement
0-100	very light	little
100-250	light	effective
250-500	heavy	effective/multiple
500+	very	heavy none (orthopedic)

Biology of Orthodontic Tooth Movement

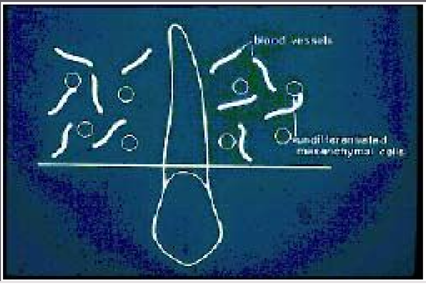

Figure 12. Undifferentiated mesenchymal cells

Prior to force: Undifferentiated (mesenchymal) cells (Figure 12)

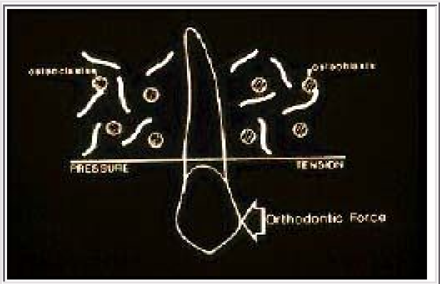

Figure 13. Osteoclasts and osteoblasts

Orthodontic force: Pressureside: osteo clasts (resorption)

Tension side: osteo blasts (apposition) (Figure 13)

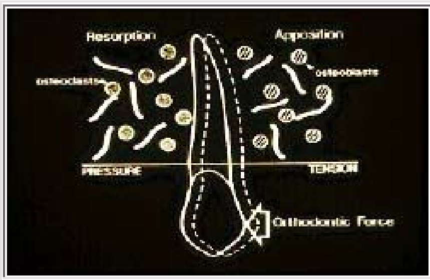

Figure 14. Orthodontic force = tooth movement

Causes tooth movement (Figure 14)

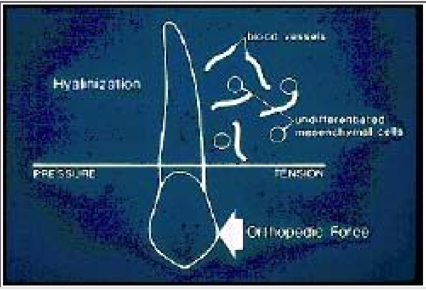

Figure 15. Orthopedic force = hyalinization

Orthopedic force:

Heavy force causes force: "hyalinization" cell-free area on pressure side–no tooth movement– forces transmitted to distant craniofacial structures and causes orthopedic correction (Figure 15)

***For optimum tooth movement, use less force on an adult as compared to a child, because the adult has a diminished blood supply, and hyalinization can occur with heavy forces.**

The above is by no means a complete description of the biology of orthodontic tooth movement. Again, the dentist should refer to the classic text books[5,6] on this subject to fully understand this most important aspect of clinical orthodontics. Nevertheless, the clinician can utilize the above summarized information to understand that light forces move teeth, and heavy forces prevent efficient tooth movement. This is contrary to what most consider logical thinking, that the more the force that is applied to a tooth, the more the tooth will move. It is most important to remember that the older the patient, the lighter the tooth moving forces should be.

A dentist may think that an adult's alveolar bone structure is "harder" than a child's, therefore more force is required to move an adult tooth. Contrary to this thinking, a heavier force on an adult is more likely to produce "hyalinization," or, a "cell free" area, incapable of any osteoclastic activity and bone resorption. On the other hand, if the clinician's goal is to use a child's tooth as an "anchor," as is the case during headgear therapy and the need for orthopedic force transmittal, then "heavy" forces should be used to accomplish this task.

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2.

Classification of Malocclusion

Introduction

It is estimated that only 1% of the population has a "perfect" occlusion. Conservatively speaking, more than 20% of the population that has a malocclusion could benefit from some type of orthodontic treatment. Therefore, it is important for the dentist to determine which of those malocclusions he or she examines needs orthodontic treatment to prevent the occlusion from becoming "pathologic."

Although we want to treat each patient as an individual, and do not want to "pigeon hole" people into "groups," certain malocclusions have certain characteristics that are common. And, since the characteristics of each malocclusion are the objects that are treated, it is important to understand these as thoroughly as possible.

Also, by classifying something, it is easier to communicate certain information to the patients as well as to other members of our profession.

It is best to use the following order to classify occlusions:

- **Individual Malpositions**
- **Horizontal and Vertical Relationships of Incisor Teeth**
- **Inter-arch Discrepancies**
- **Profile, Facial, and Dental Arch Characteristics**

- **Individual Malpositions**

The classification of a malocclusion should begin with a detailed explanation of the malposition of each individual tooth in each dental arch. The term used to describe these malpositions is "version." Different types of versions are:

Figure 16. Labioversion of mandibular incisor

Labio- or buccoversion: **This is a tooth that is misplaced to the labial or buccal side of the dental arch. (Figure 16)**

 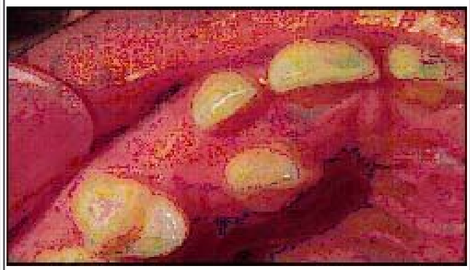

Figure 17. Linguoversion of mandibular incisor	Figure 18. Palatal version of maxillary canine

Linguo- or palatal version: **This is a tooth that is misplaced to the lingual or palatal side of the dental arch. (Figures 17 and 18)**

Figure 19. Mesioversion of maxillary first molar

Mesioversion: **This is when the tooth is displaced mesial to its normal position. (Figure 19)**

Distoversion: **This is when the tooth is displaced distal to its normal position.**

Figure 20. Infraversion of ankylosed deciduous molar

Infraversion: **This is when a tooth has insufficiently erupted, such as a "high" canine or an ankylosed deciduous molar. (Figure 20)**

Supraversion: **This is when a tooth has erupted further than usual with reference to the occlusal plane.**

Torsiversion: **This is a tooth that is abnormally rotated either mesially or distally.**

Transversion: **This refers to the situation in which one tooth has displaced another, such as when a lateral incisor and canine are interchanged.**

Of course, an individual tooth can be in several different "versions" at once. For example, a tooth may be in labio-, mesio-, supra-, and torsiversion at the same time.

- **Horizontal and Vertical Relationships of Incisor Teeth**

Incisor Overjet (Horizontal Overlap)

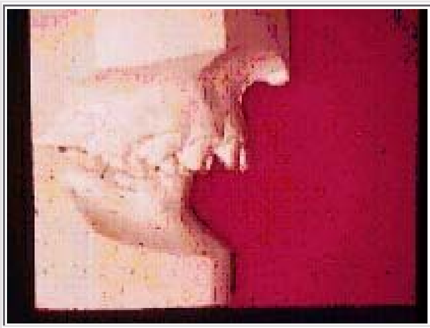

Figure 21. Excessive horizontal overlap

Certain malocclusions cause the maxillary incisor teeth to be positioned too far forward or too far behind their mandibular antagonists. When the upper incisors are protracted, this situation is referred to as an excessive "overjet" or horizontal overlap. (Figure 21)

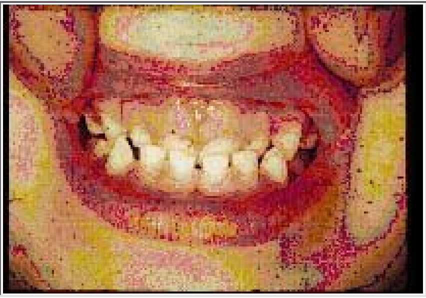

Figure 22. Anterior crossbite

A "negative overjet" situation occurs when the maxillary incisor teeth are positioned posterior to the mandibular incisors. This is referred to as an anterior crossbite. (Figure 22)

Incisor Overbite (Vertical Overlap)

Figure 23. Excessive vertical overlap

A normal overbite or vertical overlap is present when approximately 10% of the labial surface of the lower incisor is overlapped by the maxillary incisor. When either the maxillary or mandibular incisors over-erupt, the lowers are often partially or completely overlapped by the uppers. The patient is then said to have a "deep overbite," or excessive vertical overlap. The same situation would occur if the posterior teeth are infra-erupted. Figure 23

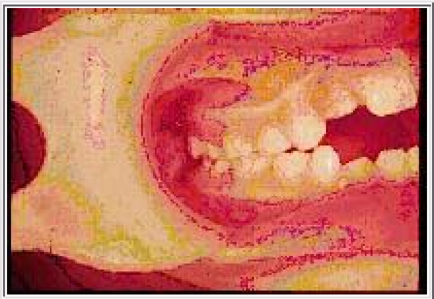

Figure 24. Anterior open bite

Contrary to this situation, certain skeletal abnormalities or extrinsic factors often cause supra-eruption of posterior teeth or infra-eruption of the incisors. In such a case the incisor teeth do not approximate in occlusion. The patient is then said to have an "anterior open bite." (Figure 24)

- **Inter-arch Discrepancies**

This portion of occlusion classification was devised by Dr. Edward Angle in 1899[7]. Since it is still being utilized today, it must have a great degree of merit. This classification assumes that the maxillary first permanent molar is in a correct position, because it is the "key" to this classification. It must be noted that Dr. Angle deter- mined this classification before cephalometric radiographs were developed, and therefore it is only a dental classification.

Class I

A Class I occlusion exhibits a well balanced muscle system, one which each clinician attempts to achieve as a final result of orthodontic treatment. It is important to note that all ideal occlusions are Class I, however all Class I occlusions are not ideal. A Class I malocclusion is associated with a normal maxillo-mandibular skeletal relationship; the discrepancy is between tooth and individual jaw size. In other words, the teeth are either crowded, or there is inter-dental spacing present.

Figure 25. Class I neutro-occlusion

As in an ideal occlusion, in a Class I malocclusion the mesiobuccal cusp of the maxillary first permanent molar occludes in the buccal groove of the mandibular first permanent molar. This is also called a "neutro-occlusion." (Figure 25)

The skeletal and musculature relationships are ideal and harmonious in a Class I malocclusion, and except for the arch length-tooth size discrepancy, this type of orthodontic problem presents the fewest treatment complications if the correct mechanotherapy is performed. (Figure 26)

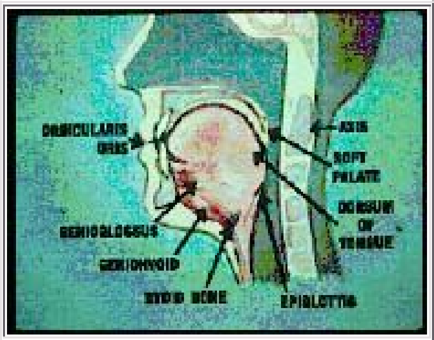

Figure 26. Class I normal relationships

A "sub-division" of a Class I occlusion is termed a "bimaxillary protrusion." This is normal and commonly observed in certain ethnic groups, where the dental, skeletal and muscular relationships are normal, but where the upper and lower dental arches are forward with respect to their bony bases.

Class II Division 1

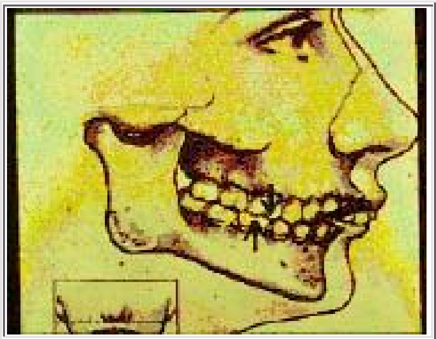

Figure 27. Class II division 1 disto-occlusion

A Class II malocclusion exists when the mandibular first permanent molar is distal to its maxillary counterpart. This is also termed a "distoocclusion," because the lower molar is distal to the upper molar. (Figure 27) It may be the result of a retrognathic mandible, a protracted maxilla, or a combination of the two. If the Class II situation is skeletal in nature, then there is said to be a "basal" discrepancy, meaning that the positioning of the base of the mandible or maxilla are at fault. The exact etiology of a Class II division 1 discrepancy, however, can only be ascertained by a lateral cephalometric analysis.

Aside from the anteroposterior skeletal discrepancy, the arches may be crowded and an anterior open bite may also be present. Because of the "overjet" of the anterior segment of the dental arch in a Class II malocclusion, the lower anteriors are free to supra-erupt toward the palate, causing a deep overbite. If there is an "anterior tongue thrust," this will prevent the incisors from supra-erupting, and then an anterior open bite will develop.

Figure 28. Class II abnormal relationships

Unlike the Class I occlusion, where a normal balance of muscle pressure exists, a Class II division 1 malocclusion exhibits abnormal musculature, often with hypotonic upper lip and hypertonic lower lip. (Figure 28) Because of the skeletal discrepancy and the muscle imbalance, the treatment of this malocclusion poses more treatment complications than do the Class I problems.

Subdivision. Often in certain Class II division 1 malocclusions, there is a situation where the occlusion is a Class I on one side and a Class II on the other. Then, it is classified as a "Class II division 1, subdivision left or right", depending on which side is Class II.

Summary of Class II Division 1 Malocclusions

♦ **Overjet**

♦ **Deep Bite or Open Bite**

♦ **Basal Dysplasia**

♦ **Changed Muscle Function**

Class II Division 2

Figure 29. Class II division 2 incisor inclinations

As in a Class II division 1 malocclusion, a division 2 also presents a disto-occlusion. This is the only relationship that the two discrepancies have in common. The typical Class II division 2 malocclusion is also characterized by a deep anterior overbite (vertical incisor overlap), lingual inclination of the maxillary central incisors, often labial tipped upper lateral incisors and an exaggerated curve of Spee in the mandibular dental arch with little or no crowding. (Figure 29)

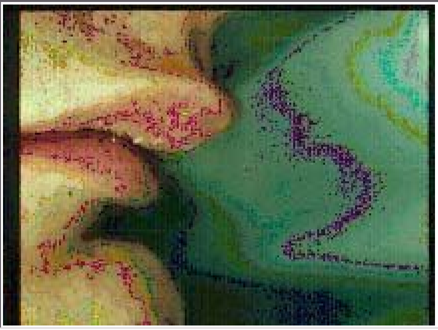

Figure 30. Class II division 2 vertical dimension

The skeletal characteristics of this malocclusion more closely resemble a Class I situation than a Class II division 1 discrepancy. The growth potential of the mandible is favorable (in a forward direction), and there are no unusual problems with the perioral musculature other than the effects of the less than normal vertical dimension. (Figure 30)

Because of the favorable growth pattern, the prognosis of a Class II division 2 malocclusion is relatively favorable if treated at an early age. However, the prognosis worsens as the age of the patient increases due to the deep overbite problem and the concomitant temporomandibular joint syndrome often associated with the over-closure of the mandible.

Class III

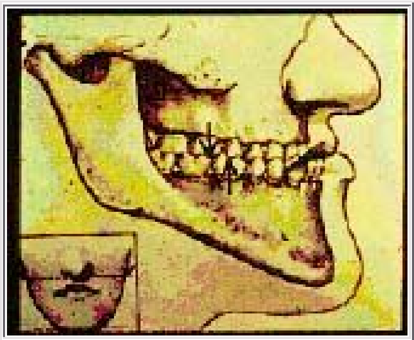

Figure 31. Class III mesio-occlusion

A skeletal Class III malocclusion is due to an over-growth of the mandible causing a mesio-occlusion and a consequent anterior crossbite. (Figure 31) In some cases, the problem is further complicated by an insufficient or retracted maxilla. Other characteristics of a mandibular prognathism are labial inclination of the maxillary incisors and lingually tipped lower incisors.

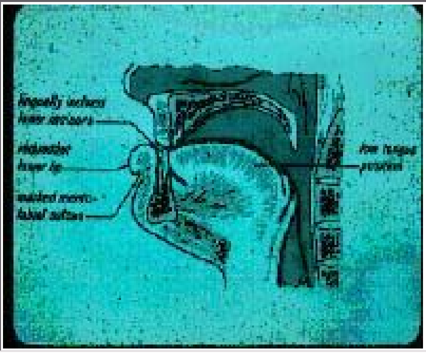

Figure 32. Class III abnormal relationships

The tongue position is usually lower than normal and the lip tonicity is opposite to that found in a Class II division 1 occlusion. That is, in a skeletal Class III malocclusion, the upper lip is hypertonic while the lower lip is hypofunctional. (Figure 32)

If treated during the growth stage of an individual, orthopedic forces can be utilized to redirect the growth of the mandible, maxilla, or both. However, if allowed to develop to maturity, a mandibular prognathism usually requires a combination of orthodontic and surgical procedures to correct.

- **Profile, Facial, and Dental Arch Characteristics**

Profile

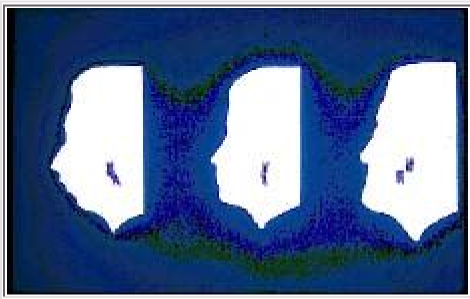

Figure 33. Convex, straight and concave profiles

The facial profile of an individual is either straight, convex, or concave, depending upon the spacial relationship of the maxilla and mandible. (Figure 33) The Class I occlusion profile is straight. Because the mandible is retrognathic in a Class II malocclusion (especially a division 1) the profile is usually convex. A protracted maxilla would accentuate this situation. The opposite is true in a Class III malocclusion. The prognathic mandible and/or retracted maxilla produces a concave profile.

Facial and Dental Arch Characteristics (Figure 34)

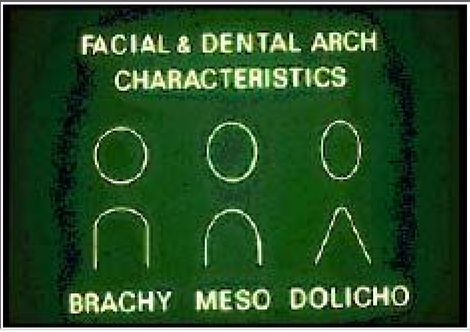

Figure 34. Facial types (above), dental arches (below)

Mesofacial: **A Class I occlusion presents with normal musculature and a pleasant ovoid facial appearance. The face is neither too long nor too wide and is associated with a similar jaw structure and dental arch configuration.**

Dolichofacial: **This type of face is long and narrow and is associated with either a Class II division 1 or a Class III malocclusion. The dental arches in these relationships are also narrow and may be associated with a "high" palatal vault.**

Because of the narrow nasal airway in these patients, they are likely to be "mouth-breathers" and cause a narrowing of the maxilla due to the abnormal forces placed on the upper jaw structure by the buccinator musculature. Because these patients keep their mouths open to breathe, there is a tendency for the posterior teeth to supra-erupt causing the mandible to grow in a vertical direction and creating a skeletal open bite.

Also, due to the small mandibular ramus, the masseter muscle on these individuals is also small, and the occlusal forces are weak. This may allow the posterior teeth to erupt more than normal with a concomitant anterior bite opening. Because of the skeletal and muscular imbalance associated with this facial type, the associated malocclusions are the most difficult to treat orthodontically.

Brachyfacial: **This facial structure is short and wide and is usually seen in a Class II division 2 type of malocclusion. The arch configuration associated with this facial type is also relatively broad and square.**

Patients of this facial type are very rarely mouth-breathers because of the relatively wide nasal airway. The mandibles of this facial type are broad and "square" with a large masseter muscle and strong occlusal forces. Because of the latter, posterior teeth are often infra-erupted causing a skeletal "deep bite." Therefore, the mandible becomes "over- closed," and these patients are often prone to temporomandibular joint problems. Treated early, however, malocclusions associated with this facial type have a good prognosis due to favorable mandibular growth.

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3.

Growth and Development

Introduction

It is an oversimplification to say that a child's head and face become bigger with age. There is a confusion by some dentists as to the difference between the definitions of growth and development, often using these words as meaning the same. The word "growth" means an increase in size. The increase in the size of a growing child is obvious to everyone. On the other hand, "development" is defined as the "progress toward maturity." These are more subtle changes than growth, and the aging process of an adult is a good example of these "subtle changes." Some of the questions to be answered regarding growth and development are:

- Do all the bones of the head and face grow at the same time?
- Do the bones grow at the same rate?
- What is the mechanism of craniofacial growth?
- How does growth affect the jaws and dentition?
- How are the principles of growth and development applied in the clinic?

Bone Growth

Before discussing facial growth, a basic understanding of the various mechanisms of bone formation should first be reviewed.

Endochondral: This is the type of bone formation that occurs in the long bones of the arms and legs. Cartilage forms the "pre-skeleton" first, which then gives way to bone formation. Endochondral types of bones are generally very hard and strong. None of the bones of the head and face are endochondral because, if they were, the head would be too heavy. Nature spared us this problem but, as it is, the average human head weighs about 14 pounds, the weight of a bowling ball! The only areas in the skull where cartilage is found are: the spheno-occipital synchondrosis; the spheno-ethmoidal synchondrosis; the nasal septum; the mandibular condyle. Note that the "cranial base," the divider between the face and brain, is made up of a dense endochondral bony structure. Perhaps this is nature's way of protecting the delicate brain from any trauma that may occur in the facial area.

Membranous: This type of bone formation does not have a cartilagenous precursor. The undifferentiated mesenchymal cells differentiate into osteoblasts and then into osteocytes and form bone. These bones are less dense and lighter than endochondral types of bones. The bones of the head and face consist of this type of bone formation. Nature has created a face that is less dense, and lighter for the patient to "carry" throughout his or her lifetime.

Theories of Craniofacial Growth

Surface Apposition: This theory states that bone is laid down on the outer surfaces of the various bones of the head and face, and this is the mechanism that causes them to increase in size. Clinically, the most important aspect of craniofacial growth is the direction of growth of the various bones of the head and face rather than their increase in size.

Endochondral: This theory states that the growth sites for this type of growth are at the various cartilagenous areas of the head and face. Namely, the spheno-occipital and spheno-ethmoidal synchondroses, the nasal septum, and the mandibular condyle. The growth in these areas literally forces the bones of the head and face to grow in a certain direction. If one wishes to pursue a more detailed explanation of this growth theory, he or she can be directed to the research efforts of Sarnat[8].

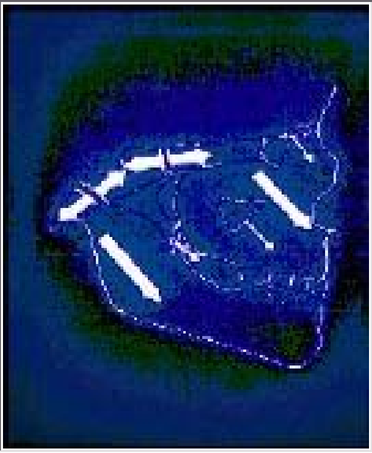

Figure 35. Downward and forward growth of facial bones

Sutural: This theory states that the connective tissue cells within the sutures (between two membranous bones) proliferate and causes the bones to be forced apart. Then, surface apposition occurs on either side of the suture which eventually closes this space. The sutures are directed in such a manner that the net direction of growth of the facial bones is downward and forward. (Figure 35) This theory was proposed by Scott in his research endeavors[9].

Functional Matrix: This theory was first discussed by M. Moss[10] from Columbia University. He states that each individual has a predetermined genetic growth potential for the size of the important matrices of the head and face. Some of these matrices are: the socket of the eye, the nasal cavities, the oral cavity, and the pharynx. According to Moss, the bones of the head and face grow to a certain size and shape around the matrices.

It is thought by most researchers that the head and face probably grow because of a combination of the above theories. The best text to read to derive a thorough understanding of craniofacial growth mechanisms is "The Human Face" by Enlow.[11]

Growth of Bodily Tissues (Figure 36)

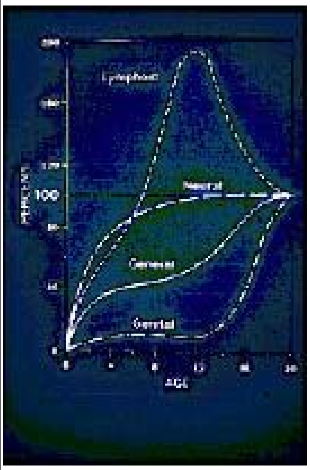

Figure 36. Growth of bodily tissues

Different tissues of the body grow at different rates and at different times. The neural tissue grows very early in life, and is well developed by the time a child is five years of age. Therefore, it is no wonder that a child at that age has the ability to learn and commence his or her schooling.

The lymphoid tissue also grows early, and even goes beyond the maximum limit of adulthood. Often this tissue proliferates to such a point that some has to be removed, hence the need for the removal of adenoids and tonsils. Adenoidectomies and tonsillectomies are not performed as frequently as in the past because of the lymph tissue's importance in the defensive mechanisms of a young child. However, in certain circumstances of nasopharyngeal obstruction causing mouth breathing and abnormal jaw development, orthodontists will refer their patient to an otolaryngologist for an evaluation for at least partial removal of the adenoid tissue.

The growth of the face closely resembles the general body growth curve. There is a specific growth spurt for boys and girls between the ages of 3 and 6 years. Often clinicians take advantage of this growth by using orthopedic appliances to correct severe incipient skeletal dysplasias. It is not unusual for a clinician to utilize orthopedic devices such as a head or neck gear for Class II cases and a chin-cup for Class III patients at this early age. These are perfect examples of early interceptive orthodontic treatment of incipient malocclusions.

After this early age, there is more or less a plateau in growth until puberty, during which time the general growth curve parallels the genital developmental curve. At puberty, the time of growth differs between males and females. For girls, this major growth spurt begins at 10 years of age and peaks between 11 and 13 years. For boys, maximum growth takes place between the ages of 12 and 16 years, with the peak around the ages of 14 and 15 years. Girls grow earlier than boys, therefore their orthodontic treatment should also precede that of boys if growth is to be utilized in the correction of malocclusions.

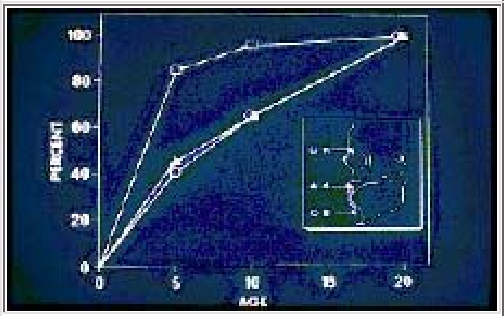

Figure 37. Differential growth rate of head

The different parts of the head also grow at different times. (Figure 37) Since the brain grows at an early age, it acts as a stimulant for the bones of the calvarium. This is the reason why young children look "top heavy," that is, the head looks bigger, proportionally, than the face and the rest of the body. The next part of the head to grow is the midface, since this is closest to the cranial base and brain. Because the midface is farther forward than the lower face, this gives a child a convex skeletal profile, similar to a mild Class II skeletal pattern. (This is a typical "transient" malocclusion that improves with normal growth.) The last region of the face to grow forward is the lower face or mandible. It finally catches up to the maxilla sometime between the ages of 10 and 15 years. The clinician can visualize the various skeletal problems that can arise if one or a combination of these three parts of the face grows abnormally.

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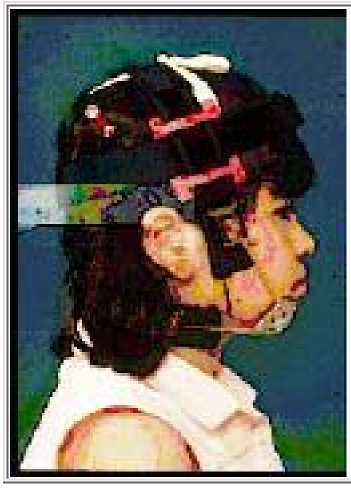
4.

Clinical Application of Growth and Development

How does the clinician apply principles of growth and development in daily practice? Certain discrepancies occur between the maxilla and mandible, as well as between tooth size and jaw size. As mentioned previously, the clinician must be able to distinguish between transient and incipient malocclusions in order to use interceptive mechanics beneficially for the patient. He or she should also know what happens to the dental arch as a child grows and develops into an adult dentition. Does it increase, decrease, or stay constant?

Orthopedic Considerations

Often a clinician may be able to use various orthopedic appliances to guide the jaws and obtain a normal maxillomandibular relationship. An example of such appliance therapy is the use of a "chin-cup" to redirect the growth of the mandible in Class III and skeletal open bite malocclusions. (Figure 38) A head- or neck-gear appliance is often used to redirect the growth of the maxilla in severe Class II skeletal discrepancies. (Figure 39)



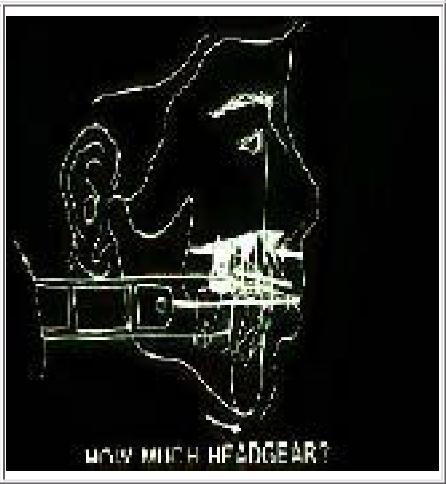


Figure 38. Chin cup appliance	Figure 39. Neck gear appliance

Dental Considerations

Figure 40. Leeway space

Leeway Space: **There is a difference between the mesiodistal widths of the deciduous molars and premolars. This is called the "leeway space." (Figure 40) The mandibular deciduous molars are larger than the maxillary deciduous molars, therefore, the leeway space is slightly greater in the lower dental arch than in the upper. Nevertheless, the transition from the "mixed" dentition to the adult dentition causes a decrease in the arch length due to the forward movement of the permanent first molars into the leeway space. The "flush terminal plane" occlusion of the permanent first molars in the mixed dentition is a transient malocclusion and recovers autonomously into a Class I relationship as the lower molar moves forward a greater amount than the upper.**

Incisor Liability: **What about the anterior region? Here, nature is not so kind to the patient in terms of transition. There is a "liability" between the deciduous incisors and their permanent successors.**

Lower arch mesio-distal diameters:		
Permanent centrals	(5.4mm x 2)	10.8mm
Permanent laterals	(5.9mm x 2)	11.8mm
	Total Width	22.6mm
Deciduous centrals	(4.2mm x 2)	8.4mm
Deciduous laterals	(4.1mm x 2)	8.2mm
	Total Width	16.6mm
	Incisor Liability:	-6mm

Mandibular incisor liability of -6mm overcome by:

1. Interdental spacing of 2.7mm

2. Intercanine growth of 3.0mm

3. Anterior incisor positioning of 1.3mm

4. Combination of 1, 2 and 3 in varying degrees.

Growth occurs at the midpalatine suture of the maxilla and at the symphysis of the mandible to accommodate the larger permanent incisors. But the suture between the maxillae stops growing actively between the ages of 7 and 9 years, whereas the mandibular symphysis "closes" during the first year of life. Therefore, normal sutural growth does not keep pace with the incisor liability.

Interdental spacing in the deciduous incisor region is the most important means for a harmonious transition between the mixed and permanent dentition. (Figure 41) If no spaces exist between the deciduous incisors, it is safe to say that the result will be crowding of the permanent teeth. (Figure 42)

Sequence of Tooth Eruption

Just as important as space consideration in the dental arch is the sequence of eruption of the permanent teeth. Although it is important to know the calcification and eruption dates of the different teeth, it is more important to know and preserve their proper eruption sequence. It is also important to realize that the

sequence of eruption in the upper dental arch differs from that in the lower dental arch. In the maxillary arch, the canines erupt after the first and second premolars. In the mandibular arch, the premolar teeth follow the eruption of the canines.

There is a difference in the prevalence of tooth impaction between the upper and lower arches. In the maxillary arch, it is common to see an impacted canine since this is the tooth that is "short-changed" if a lack of space exists. In the lower arch, the second premolar is most commonly impacted, as it erupts after the canine and first premolar.

"Ugly Duckling" Stage of Dental Development

Because the maxillary permanent canines are late in their eruption pattern, the upper incisors often flare distally and cause spacing in the anterior region of the dental arch.

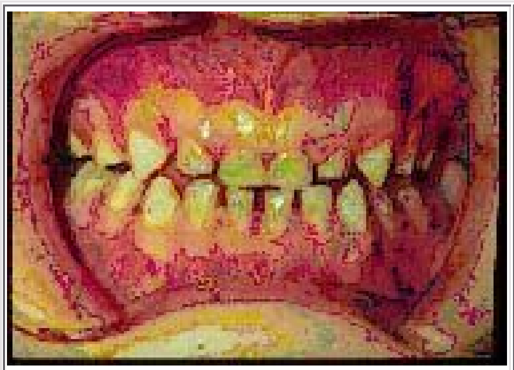


Figure 41. Interdental spacing

Figure 42. Crowding of deciduous incisors

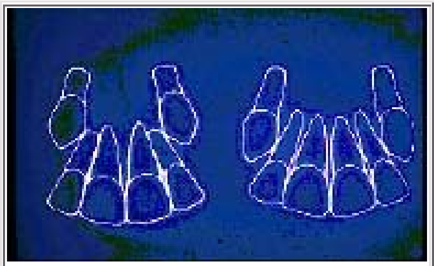


Figure 43. Distal flaring of maxillary incisors

This is termed the "ugly duckling" stage of dental development.[12] The apices of the incisor teeth are together because the canines are pressing against these teeth, and the width at the base of the nose has not yet attained its proper dimensions. (Figure 43) As more growth takes place in this region, and as the canine teeth erupt, the incisors will move together and this transient malocclusion will correct itself.

References

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5.

Cephalometric Determinations

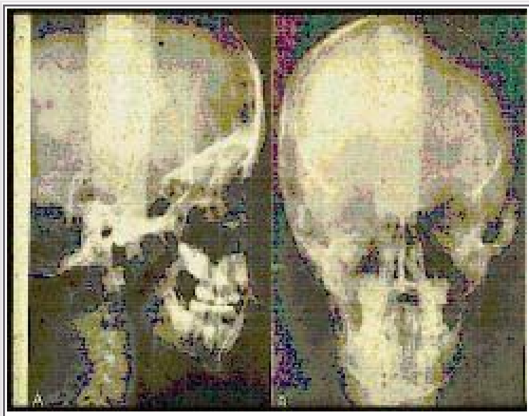

Figure 44. Lateral and frontal cephalometric radiographs

Although a discussion of cephalometrics is a course in itself, it is difficult to discuss growth and development without mentioning this important diagnostic tool. In 1931, Dr. B. H. Broadbent, an orthodontist, developed radiographic cephalometrics as a method to study the growth and development of the craniofacial complex. [13] (Figure 44) It later became the most important diagnostic tool for orthodontic treatment.

Most contemporary orthodontists use cephalometrics in performing growth forecasts of their patients. Short term growth forecasts, for periods up to 4 years, can be performed manually.[14] Computers are now used to perform long term growth forecasting for periods of 10 years and more.[15]

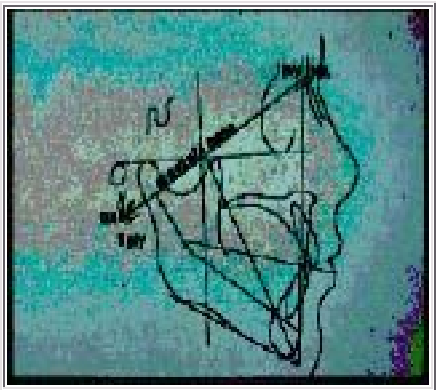

Figure 45. Growth of cranial base

To give you some idea of how craniofacial growth takes place, the cranial base, a line depicted between "Basion" (anterior point of the foramen magnum) and "Nasion" (fronto-nasal suture) grows approximately 2mm per year during the active growth of an individual. (Figure 45)

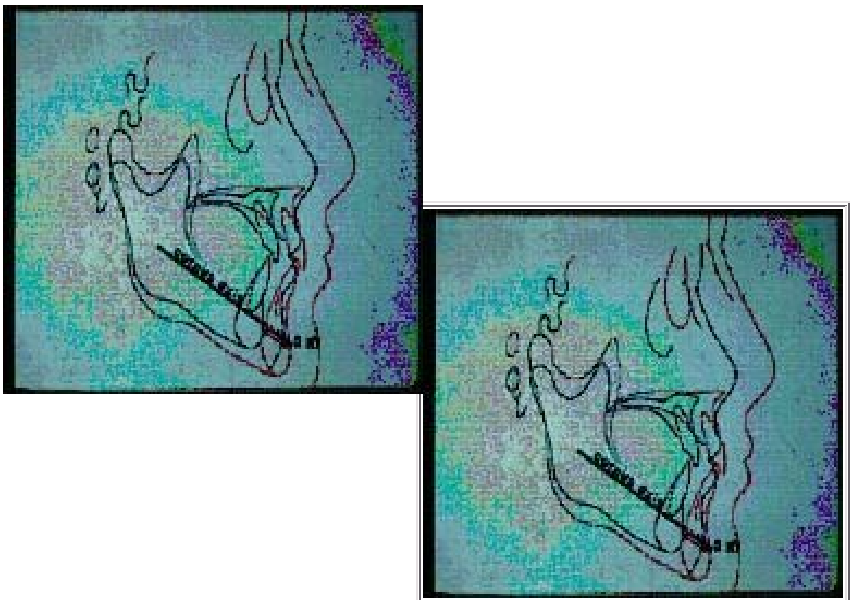

Figure 46. Growth of mandibular corpus

The "Corpus Axis," a line from a point above the chin on the outer surface of the mandibular symphysis to a point representing the center of the mandibular ramus also grows 2mm per year. (Figure 46) Therefore, there is a 1:1 ratio between the growth of the cranial base and the growth of the body of the mandible in a normal individual, as in a Class I situation. (Figure 47) In a Class II division 1 patient, this ratio may be in the range of 1:0.5, and in a Class III it may be as large as 1:3. Interestingly, research performed at the University of California, Los Angeles, found that Class II division 2 patients have a ratio of 1:1.5 and as great as 1:2 when the upper incisors are tipped forward and the bite opened.[16] This may be attributed to what is termed "rebound growth."

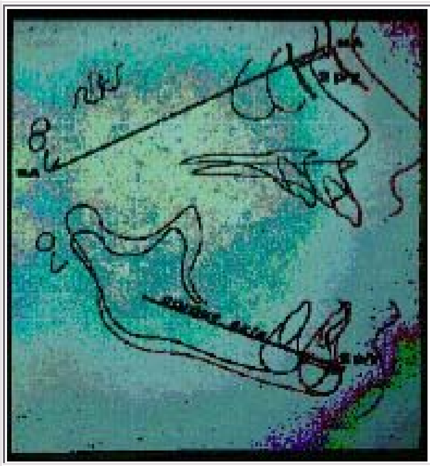

Figure 47. Growth ratio of cranial base and mandible

In other words, the mandible "catches-up" to its normal growth pattern in certain Class II division 2 patients, once the lower jaw is "unlocked" by the anterior deep dental bite. Oftentimes, a simple appliance such as a removable anterior bite plate can be utilized by the clinician to not only allow for the eruption of posterior teeth to open the bite, but also enable the mandible to follow its "morphogenetic" growth pattern.

The facial axis is a line from PT point (foramen rotundum of the sphenoid bone) to a point on the chin (GN or Gnathion on the mandibular symphysis). It grows an average of 3mm per year. (Figure 48) It forms an angle with the cranial base (Ba -N), and this is 90 degrees in a normal Class I patient. (Figure 49) In this situation, the mandible's growth is equal in its downward and forward direction. A small angle of less than 90 degrees indicates a more downward direction of mandibular growth.

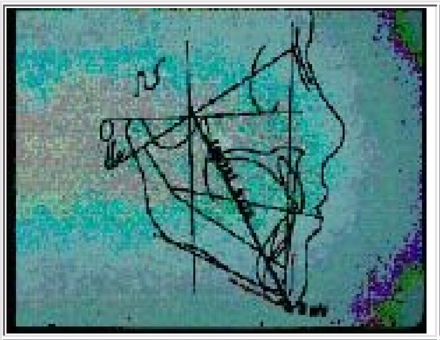

Figure 48. Growth of facial axis

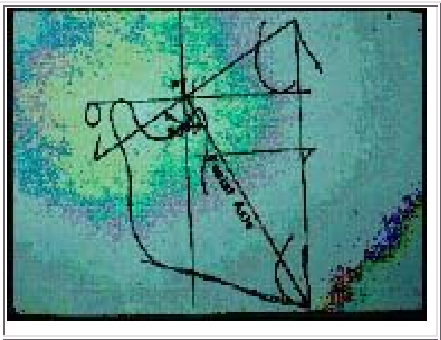

Figure 49. Facial axis angle

This is seen in Class II division 1 dolichofacial patients, and is not favorable for the self correction of the Class II malocclusion.

On the other hand, if the "facial axis angle" is greater than 90 degrees, it would indicate a more forward growing mandible. This is usually the case in Class III developing malocclusions, and often in Class II division 2 patients. The latter is an indication that in brachyfacial individuals, mandibular growth is favorable as far as the prognosis of the treatment of the Class II situation.

The term "differential diagnosis" was defined in an earlier chapter to be "the process whereby the dentist determines the degree of difficulty of the orthodontic problem." The clinician can then determine whether or not to treat a malocclusion or refer a difficult problem to an orthodontic specialist. There is not a better single criterion than the facial axis angle to determine the degree of difficulty of a malocclusion, especially in the growing child.

This is why it should behoove the general dentist to learn as much as he or she can about the art and science of cephalometric analysis. There are numerous research articles and textbooks available to learn this most important diagnostic tool. [17], [18], [19]

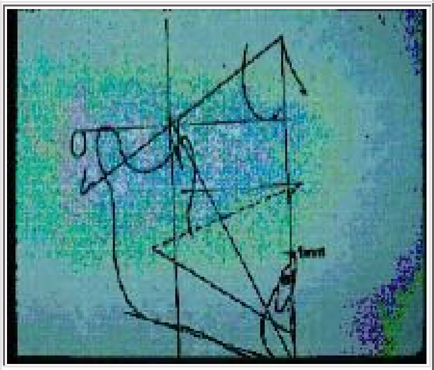

Figure 50. Lower incisor relationship to APo line

Another most important diagnostic cephalometric measurement for the general practitioner is the distance between the tip of the incisal edge of the lower central incisor and a line between the "apical base" of the maxilla (A point) and the tip of the chin (Pogonion or Po). (Figure 50) The latter line is called the "APo" line and is really the axillomandibular line, since it connects the upper and lower jaws.

In a normal Class I individual, this measurement should be +1mm. In other words, the mandibular central incisor should be 1mm ahead of the APo line. In various malocclusions, the lower incisor can be further forward as in a bimaxillary protrusion, or in cases of thumb sucking, it could be lingually positioned in reference to the APo line.

The position of the lower incisor in a labio-lingual direction is obviously going to effect arch length. Any movement of the lower incisor labially or lingually is going to effect the arch length by twice as much. In other words, if the lower incisor is +6 to the APo line, and it is tipped back to the normal +1, there is going to be a decrease of the arch length by 10mm. Other teeth would probably have to be extracted in order to accomplish this orthodontically. On the other hand, if the lower incisor needs to come forward 5mm, this will increase the arch length by 10mm, and the clinician would more than likely be able to treat the case without the extraction of teeth.

It is often said by orthodontic specialists that they would prefer utilizing cephalometric analyses to determine the degree of difficulty of a malocclusion, rather than just a set of study models of the teeth. This is contrary to the thought of many general dental practitioners who more often use only study models to try and determine the extent or seriousness of an orthodontic problem. Nonetheless, it can easily be seen after the above discussion of the importance of the relationship between the lower incisor and the APo cephalometric line that one must use cephalometrics, in conjunction with study models, in order to perform an accurate arch length-tooth mass analysis to determine the extent of crowding or spacing in a dental arch.

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Contents

1. Principles of Removable Orthodontic Appliances

Introduction

Orthodontic specialists, especially those trained in the United States, have minimized the use of removable orthodontic appliances. This is mainly due to their postgraduate training in the exclusive use of fixed appliances, as well as the fact that "older" clinicians never had the opportunity to utilize removable appliances in their undergraduate orthodontic training, since this curriculum did not exist in the "old days." Another reason for the exclusive use of fixed orthodontic appliances by specialists in this country is the strong educational influence that the "father of modern orthodontics," Dr. Edward Angle, had not only on past clinicians but even the contemporary orthodontists[(1),(2)]. His strict disciplinary approach and his dogmatic use of fixed appliances still ring in the minds of orthodontic specialists today. In fact, the edgewise fixed orthodontic appliance developed by Dr. Angle in 1928 is still being utilized today, with some variations[(3)]. Also, orthodontic specialists have the feeling that removable appliances should be limited to retention after active orthodontic therapy. This notion could be traced to the early publication in 1919 by Dr. C. Hawley who wrote about his "Hawley retainer," a removable appliance that is still popular and utilized today[(4)].

Clinicians in other countries, especially those from European nations, have always been very well versed in the utilization of removable orthodontic appliances[(5)]. Some well known clinicians even pioneered the use of certain removable appliances to stimulate, or at least help to develop the growth of jaw structures[(6),(7)]. These dentists have known how to utilize removable appliance therapy, and most importantly, the appliances' limitations.

There is an axiom that has dwelled in the mind of the author, learned early from a progressive orthodontic educator, Dr. T. M. Graber, who has even advocated the use of removable bite plate appliances to aid in the treatment of certain temporomandibular joint disorders [(8)]. The axiom is: "The tooth does not know what appliance is being used." In other words, if the clinician thoroughly understands the diagnosis of a particular case, he or she should be able to use the

appropriate orthodontic appliance, whether removable or fixed, to "get the job done." Because of Dr. Graber's influence, along with study and clinical experience, the author has always advocated the use of proper removable appliance therapy[9]. As we have learned from our European colleagues, not all cases can or should be treated by the use of removable appliances. Hopefully, the writings in this book will aid the dentist in the proper use of removable orthodontic appliances, as well as their limitations.

A removable orthodontic appliance is one which is easily removed for cleaning, but which is firmly attached to the supporting structures so that controlled pressure is brought to bear on the teeth to be moved. The design and construction of any removable orthodontic appliance must begin with a detailed plan of the tooth movement that is to be carried out in the course of the treatment of a particular case. If the treatment is at all complicated, it is important to consider how many movements can be carried out with one appliance alone or, if necessary, to break down the treatment plan to a series of simple tooth movements, using a separate appliance for each.

Figure 1. Bird beak or #139 pliers.

Figure 2. Pyramidal beak (left) and cone-shaped beak (right).

Figure 3. Finger and pliers placement for bending wire.

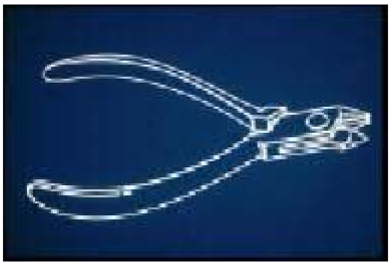

Figure 4. Three-pronged pliers.

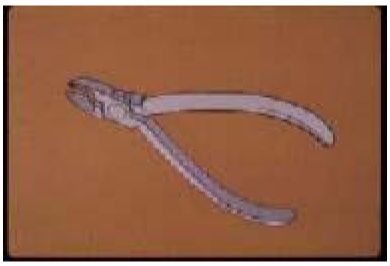

Figure 5. Pin- or ligature-cutting pliers.

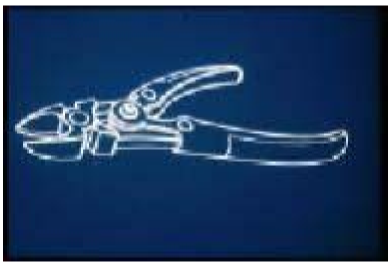

Figure 6. Hard wire cutter.

Instrumentation

Proper instrumentation is as important in orthodontics as it is in other clinical dentistry procedures. Whether sharpening the line angles of a cavity preparation or placing an important bend in an arch wire, the clinician must properly manipulate various instruments. The average dentist, however, is relatively unfamiliar with orthodontic instrumentation because of the limited experience afforded in most dental school curricula. Therefore, an attempt will be made to illustrate and explain the use of the basic pliers and orthodontic instruments necessary for the construction of removable orthodontic appliances.

Wire Bending Pliers

- Bird beak pliers. (Figure 1) Perhaps the most versatile pliers in orthodontics, the "bird beak" (#139) pliers are used to bend a variety of different arch wires. They are utilized to place various horizontal, vertical, and loop bends in light labial wires as well as to contour heavier lingual arches. It is a well known fact that many of the "older" orthodontic specialists used these pliers almost exclusively in the bending of the various wires used in clinical practice. The pyramidal beak is used to place sharp bends in the wire, whereas loops and more gradual bends are placed with the cone-shaped beak. (Figure 2) Although the beginning clinician seems to want to always attempt to bend wire with the pliers, it is important to remember that for control of the actual bends, the wire should be held with the pliers and bent with the fingers. (Figure 3)

- Three-pronged pliers. (Figure 4) The three-pronged or three-beak pliers obviously derive their name from the number of "beaks" of these particular pliers. They are used mostly to bend large round arch wires that are difficult to manipulate with the bird beak. The pliers are utilized by placing the wire between the two beaks on one side and the single beak on the other. By pressing the handles toward each other, the wire is gradually bent around the single beak. The closer the handles are squeezed together, the sharper is the angle that is placed in the wire. Although these pliers seem to be relatively "work free" in manipulating the bend in a wire, the clinician does not have the "feel" of the various bends as he or she would have with the aforementioned bird beak pliers. This is the reason why the three-pronged/beak pliers should only be used for bending larger gauged wires.

Wire Cutters

- Pin- or ligature-cutting pliers. (Figure 5) This fine instrument should only be used to cut small gauges of "dead soft" stainless steel ligature wire. Its small and delicate beaks can easily be damaged if they are used for any other purpose. It must be remembered that orthodontic pliers are precision instruments, and are very expensive for the clinician to replace. Therefore care must be utilized in order to prevent damage during the use of these instruments.
- Hard wire cutter. (Figure 6) The beaks of this wire cutter are sufficiently sturdy to cut most gauges of orthodontic wire. It is extremely important to remember never to use this wire cutter intraorally, and to always hold on to the wire securely on either side of where the cut is to be made. This will avoid possible injury by a projected segment of the cut wire.

Orthodontic Wires

A more detailed explanation of the types of wires used in orthodontic clinical practice will be given later in the text when fixed appliance therapy is discussed. The basic wires used for removable orthodontic treatment are made from a stainless steel material and are almost always round in shape. Therefore, the following is a discussion of the various wire sizes used in the construction of removable orthodontic appliances.

Wire Size

Along with the proper instrumentation, the clinician should be aware of the various wire sizes used in the construction of most removable orthodontic appliances. As mentioned previously, round stainless steel wires are usually used for these types of appliances. Although the metric system is used in most countries other than the United States, the size of a round wire utilized for orthodontic purposes is universally designated by the diameter of the wire in inches.

- Labial Wire - 0.032"
- Finger Springs
  - Anterior - 0.022"
  - Posterior - 0.025"
- Clasps - 0.025"

Acrylic and Wire Appliances

Introduction

The most common removable appliances used for "active" orthodontic tooth movement are the acrylic and wire appliances. "Active" treatment is differentiated from "passive" treatment, the former being defined as the actual treatment of a particular case, and the latter meaning the retentive part of the therapy. Retainers can also be acrylic and wire appliances, but in most cases, they do not contain the "active elements" of an appliance, which are the various finger springs that cause tooth movement when activated.

The design of a removable appliance will be considered to be composed of three parts. (Figure 7): 1) the acrylic baseplate that covers the palate of the maxilla or the lingual tissue of the mandible, 2) the retentive clasps around the premolar and molar teeth, and 3) the active elements.

Baseplate (Figure 8)

The greatest portion of a removable orthodontic appliance is the baseplate. It is usually made of acrylic and has three main purposes: 1) Acts as a vehicle and carries all working parts and active elements such as clasps and finger springs. 2) Serves as anchorage or retention. It must be remembered that similar to removable prosthetic appliances, removable orthodontic appliances are primarily "tissue-bearing" appliances, and close adaptation is essential for proper retention of the appliance. 3) Acts as an active element of the appliance.

With regard to the baseplate being a part of the active element of the appliance, an anterior bite plate is often built into the baseplate. (Figure 9) The lower incisors occlude on the acrylic behind the upper anterior teeth, the posteriors are out of occlusion, and this allows the latter teeth to erupt and concomitantly open the bite in deep overbite cases. (Figure 10) The clinician, however, should understand the basic fundamentals of clinical cephalometrics with respect to the patient's facial type and vertical dimension before he or she attempts to open a patient's bite in this manner.(10)

The baseplate may also be utilized to expand the maxillary dental arch. (Figure 11). Differential diagnosis is important in order for the clinician to determine whether the constriction is due to a collapsed dental arch, or due to insufficient maxillary growth. The difference between orthodontic and orthopedic forces must be understood as well as the importance of the extra-oral muscle forces.[10]

Figure 7. Acrylic and wire appliance - acrylic baseplate, retentive clasps, and active element.

Figure 8. Acrylic baseplate of removable appliance.

Figure 9. Anterior bite plate.

Figure 10. Deep overbite (vertical incisor overlap).

Figure 11. Maxillary expansion appliance.

Figure 12. Maxillary baseplate covers entire palate.

Planning of Anchorage

For every action, there is an equal and opposite reaction. Every spring pressing against the tooth develops force in the same quantity against the baseplate of a removable orthodontic appliance. After the directions of the tooth movement are carefully analyzed, it is necessary to assess the reaction which will be produced and to make plans for suitable teeth to resist it.

Maxillary Appliances

In the maxillary removable orthodontic appliance, it is usually better to cover the entire palate at least to the distal side of the first molar. (Figure 12) This is accomplished for two reasons: 1) This type of design is intrinsically stronger and provides more anchorage than the so-called "horseshoe" appliance which only partially covers the palate; 2) The tongue is less likely to catch and dislodge the appliance under a complete acrylic palate. Many clinicians mistakenly feel that covering the entire palate will elicit a "gag" response from the patient. However, it must be remembered that the patient's gag reflex is on the base of the tongue and not on the palate.

During this author's early training, an astute clinician showed him the best method of taking an impression of a patient with an overly sensitive gag reflex. That is, to lean the patient back in a horizontal position so that the patient's tongue drops down toward the throat. Then, seat the distal portion of the impression tray toward the back of the palate first, and allow any excess impression material to flow forward toward the incisor region as the tray is fully seated.

Mandibular Appliances

The lower baseplate presents special problems. (Figure 13) Because the lingual sulcus is shallow, it is necessary to make the lower baseplate shallow as well, and thus some extra thickness is often needed for strength. Also, there is usually a deep lingual undercut in the molar area, and it is then necessary to "ease" the baseplate in this region and to avoid these undercuts. Figure 14 illustrates how a clinician can construct a lower baseplate properly by "blocking out" the lingual undercuts prior to the construction of a mandibular removable appliance.

Retentive Clasps

Although most of the retention capability of a removable appliance is accomplished by adequate tissue adaptation of the baseplate, most appliances require some form of wire retentive clasps to provide the stabilization needed. The type of clasp chosen for added retention of a removable orthodontic appliance depends on the undercuts or on the retention surfaces of the teeth to be clasped. (Figure 15) There are several types of retentive clasps that help distribute the active force through the baseplate into the soft tissue. As mentioned previously, 0.025" round stainless steel wires are used in the construction of retentive clasps.

Circumferential Clasp (Figure 16)

This is one of the most commonly used clasps for retention of removable orthodontic appliances. It should be especially designed to take advantage of the undercuts found mesially and distally on the buccal aspect of the permanent molars. Accordingly, when this type of molar clasp is used, a maximum length of wire should lie along the gingival area of the tooth in order to take full advantage of all the existing undercuts on the mesial, distal, and buccal surfaces of the tooth. (Figure 17)

Adams or "Arrowhead" Clasp (Figure 18)

This is one of the most efficient clasps used for retentive purposes. This clasp brought to the removable appliance technique the great advantages of extreme security and reliability of retention on semi-erupted teeth, features which could not always be achieved with the circumferential clasp. There are several important points to remember about the arrowhead clasp: 1) The "arrowhead" should not touch the adjacent teeth. 2) The "bridge" of the clasp should lie approximately 2mm clear of the buccal or facial surface of the tooth. 3) The "arrowhead" should be in contact with the tooth only at the extreme ends. (Figure 19) There is nothing to be gained by making the bends excessively sharp, as this will only weaken the wire and increase the possibility of breakage.

Ball Clasp (Figure 20)

A third and popular type of retentive clasp is named the "ball" clasp. It derives its name from the tiny ball at the end of the wire that crosses from the baseplate at the interproximal area of two posterior teeth. The ball is bent toward the interproximal surfaces of those two posterior teeth, taking advantage of the undercut surfaces in that area. Care must be used not to bend the ball too far in toward the gingiva as to not cause any tissue irritation.

Action of Removable Orthodontic Appliances

The action of a removable orthodontic appliance depends on the action of the auxiliary springs used. In planning the design of the auxiliary springs, it is important to design a spring that will exert suitable pressure over an adequate distance. Springs may be divided into three different types: the labial wire spring, the free-ended springs, and the accessory spring.

Labial Wire Spring (Figure 21)

This spring is attached at both ends of the baseplate, as in the Hawley labial wire. This appliance is similar in design to the Hawley retainer appliance mentioned previously.(4) (Figure 22) As will be illustrated later in this text, the Hawley appliance can be an "active" appliance as well as a "passive" retainer, by certain activations of the labial wire. (Figure 23) The labial wire should be bent in progressive stages with extreme attention to accurately fit at each step to ensure a well-formed arch.(Figures 24-26) As mentioned previously, 0.032" stainless steel wire is used in the construction of labial wire springs.

The Hawley wire is probably the most common spring used in removable orthodontic appliance therapy. It can be utilized in both the maxillary and mandibular dental arches for palatal or lingual tipping of the incisor teeth. The indication for its use is generalized anterior spacing caused by excessive labial tipping of anterior teeth. The activation of the loops applies a lingual or palatal force on the labial surfaces of the anterior teeth, and the removal of the acrylic on the lingual or palatal aspect of the baseplate guides the teeth in a posterior direction. A lower Hawley appliance often is used to fulfill the objective of procedural movement which has been discussed in the literature.(10). Often,

mandibular anterior teeth must be retracted first in order to make possible the palatal movement of the maxillary anterior teeth.

Figure 13. Mandibular removable orthodontic appliance.

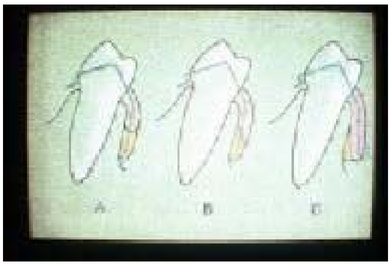

Figure 14. A) and B) the baseplate is made too short; C) the plate is made longer by blocking out undercuts.

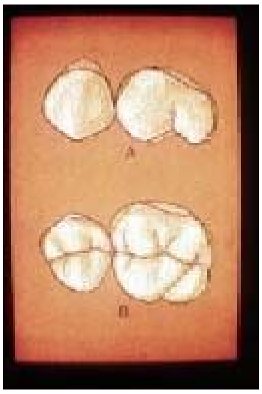

Figure 15. A) buccal and B) occlusal views of undercut areas.

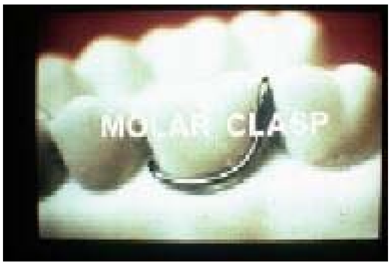

Figure 16. Circumferential clasp

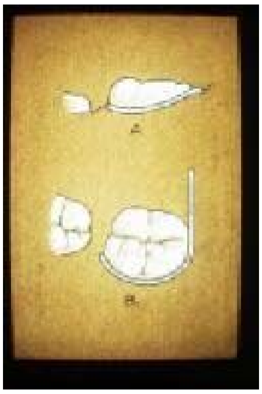

Figure 17. A) buccal and B) occlusal views of clasp.

Figure 18. Adams or "arrowhead" clasp.

Figure 19. "Arrowheads" contacting mesial and distal undercuts.

Figure 20. Ball is bent at interproximal undercut areas.

Figure 21. Hawley labial wire.

Figure 22. Upper and lower "active" Hawley appliances.

Figure 23. Activation of Hawley loop.

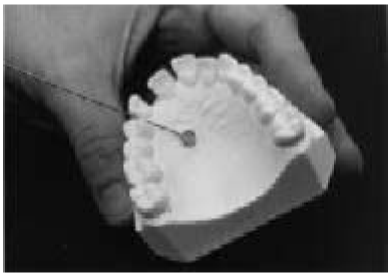

Figure 24. Palatal portion of Hawley wire to be embedded into acrylic baseplate.

Free-ended Springs

Mattress Spring (Figure 27)

The mattress spring is an example of a free-ended spring. It is utilized for labial movement of teeth in crossbite, if the crossbite is not a symptom of a general malocclusion, if there is adequate space in the arch at the site of the crossbite, and if the tooth in question is sufficiently complete in its development. (Figure 28) By judicious use of adjustments made to a labial Hawley wire, in combination with the mattress spring, a clinician can also cause a tooth to rotate around its long axis. (Figure 29) Figures 30 through 34 illustrate the fabrication as well as the activation of a typical mattress spring. As mentioned previously, 0.022" and 0.025" stainless steel wires are used in the construction of anterior and posterior free-ended springs, respectively.

Helical Coil Spring (Figure 35)

The helical coil spring is another example of a free-ended spring. Its purpose is for mesial or distal tooth movement after teeth have drifted into an edentulous area. (Figure 36) Figures 37 through 40 illustrate the construction of a typical anterior helical coil spring. In order to activate this finger spring, the clinician needs to bend the anterior portion of the spring to its range of potential activity, which is usually one-half the mesio-distal distance of the tooth to be moved, in the direction of the desired tooth movement. (Figures 41 and 42)

Accessory Spring

An accessory spring is one which is attached to the main arch or element of an orthodontic baseplate. Usually, an accessory spring is used to accomplish relatively minor tooth movement along with the primary treatment procedures. A good example of the use of an accessory spring is to "tuck-in" a labially displaced canine tooth or guiding teeth into the dental arch as they erupt. (Figures 43 and 44)

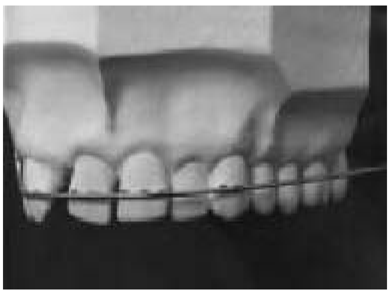

Figure 25. Hawley wire lies on the middle 1/3 of incisors.

Figure 26. Hawley labial wire with canine loops.

Figure 27. Mattress spring to advance upper lateral incisor.

Figure 28. Wire on top of mattress spring to keep it on the cervical portion of the tooth when activated.

Figure 29. In combination with the Hawley wire, a mattress spring can help rotate a tooth.

Figure 30. First bend of mattress spring is made with the conical beak of the #139 pliers. Width of finger spring is about the same as that of the tooth to be moved.

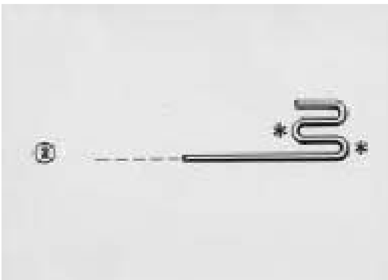

Figure 31. Each consecutive bend is similar to the first, keeping the entire spring in the same plane.

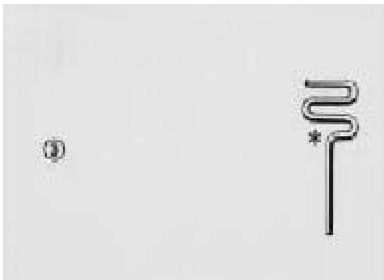

Figure 32. The retentive portion of the spring should be of sufficient length to be embedded in the palatal acrylic.

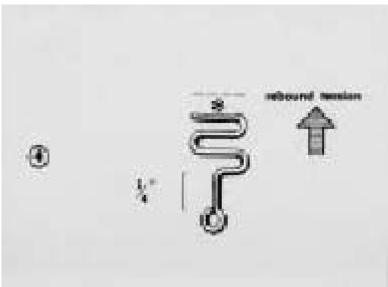

Figure 33. In order for the spring to be active, the legs should be compressed together prior to placement against the tooth to be moved.

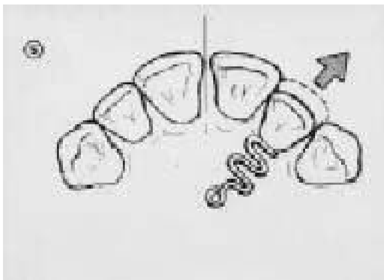

Figure 34. The compressed legs of the mat-tress spring exert a labial force on the lateral incisor.

Figure 35. Helical coil spring to move a central incisor toward the midline.

Figure 36. Two helical loop springs can be constructed from the same wire when adjacent teeth have encroached into an extraction space.

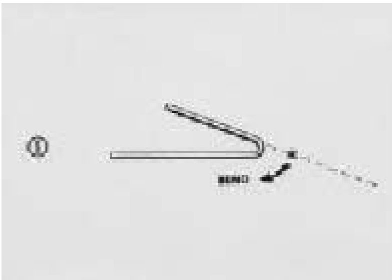

Figure 37. The helical loop spring construction is begun by bending the 0.022" wire with the conical beak of a #139 pliers.

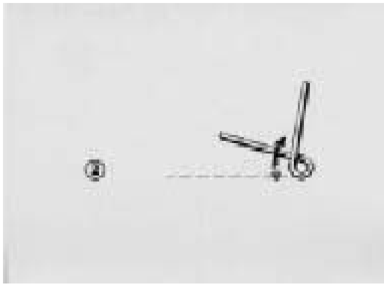

Figure 38. The second bend is made so that the legs make a right angle with each other.

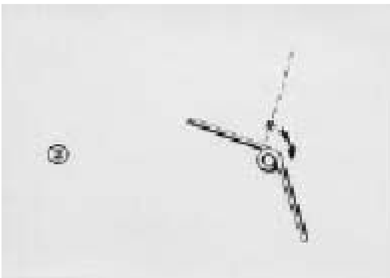

Figure 39. The retentive leg of the spring is bent so that an obtuse angle is made with the active portion.

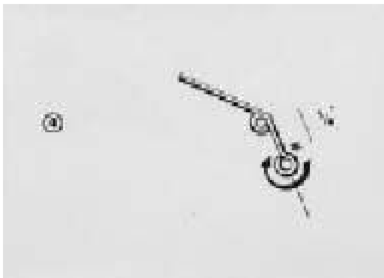

Figure 40. The retentive leg is completed by bending the end in a circular manner, which is then embedded into the palatal acrylic.

Figure 41. The range of potential activity of the helical loop spring extends approximately to the midpoint of the mesio-distal dimension of the tooth to be moved.

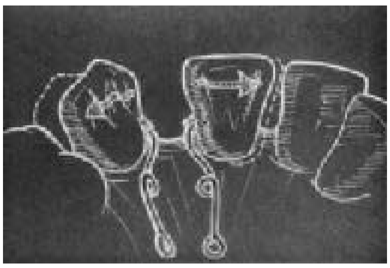

Figure 42. As the helical loops unwind, the central incisor will move to the mesial and the canine to the distal to open the space for the missing lateral.

Mechanics of Action

In discussing how to plan anchorage, the importance of such physical laws as action-reaction was stressed. It will also help the clinician to know other features of the mechanical action involved. For example, much depends on the physical properties of the wire used.

Physical Properties of Wire

The properties of the free-ended and accessory springs are those of hard polished stainless steel round wire. Within certain limits, the same force may be exerted by a thick wire as by a thin one. The difference is due to the degree of deflection needed to produce the force. (Figure 45) Also, due to the greater range of action, a longer spring will move a tooth a greater distance than a short spring.

In orthodontic therapy, the properties required are generally those of a long spring, but this is frequently inconvenient because of the limited space that is available. This disadvantage is overcome by disposing some of the surplus length of wire in the form of a coil. (Figure 46) The coil has the effect of increasing the flexibility of the spring without increasing the length of the arm.

Figure 43. An accessory spring soldered to a Hawley wire to "tuck- in" a labially displaced premolar.

Figure 44. Accessory springs to guide the eruption of the maxillary lateral incisors.

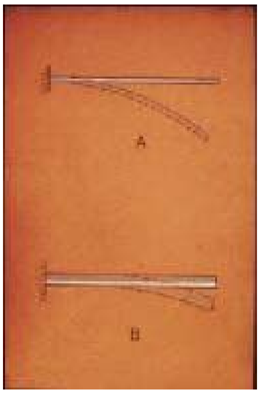

Figure 45. The thin wire A) must be deflected more than the thick wire B) to produce the same amount of force.

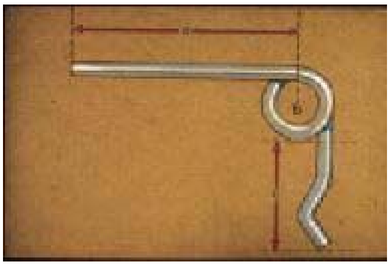

Figure 46. The introduction of a coil at the point of attachment of the arm has the effect of increasing the flexibility or range of the spring without increasing the length of the arm; a) represents the arm, b) the coil, and c) the tag.

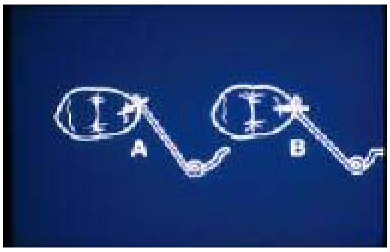

Figure 47. Arrows show different motions resulting from slightly different points of contact of the springs. In A) the premolar will move toward the distal-buccal, in B) it will move in a buccal direction only.

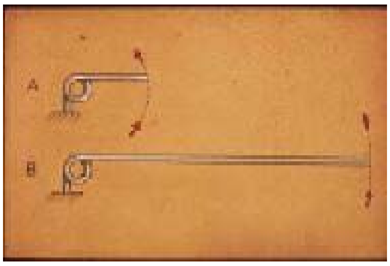

Figure 48. Because of the difference of the length of the arms, B) has a straighter vector force than A).

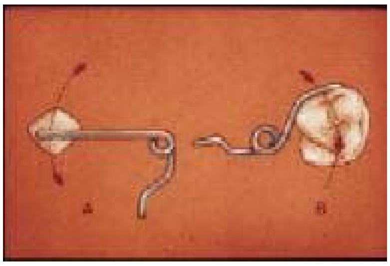

Figure 49. Because of the longer arm, A) will move the tooth in a straighter path than will the shorter arm B).

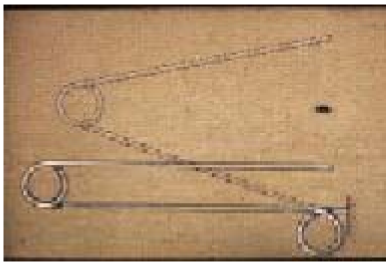

Figure 50. An additional coil and arm incorporated in a spring in order to increase the range of action.

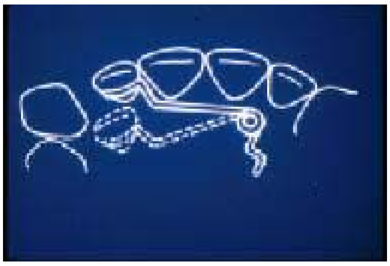

Figure 51. A compensatory bend incorporated in the arm of a finger spring to avoid adjacent teeth during treatment.

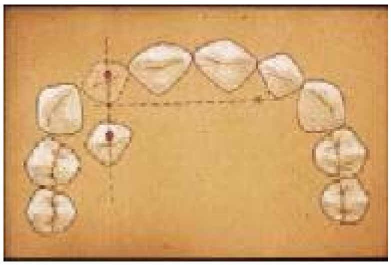

Figure 52. The coil is placed on the imaginary perpendicular bisector which is drawn to another imaginary line (left) that connects the present and desired position of the malposed tooth.

Figure 53. Coil should be placed as far from the point of tooth contact as possible in order to produce maximum range of force and a straighter path of tooth movement.

Vectors of Force

There are certain points to remember when using removable appliances for limited orthodontic treatment.

1. **It is almost impossible to grasp a tooth with the arm of a finger spring. The direction in which a tooth is "pushed" is, therefore, determined by the point at which the spring contacts the tooth. (Figure 47)**
2. **Movement of the arm of a finger spring of a removable orthodontic appliance will always be radial, and movement on any point of it will be part of a curve with its center at the coil. Therefore, the longer the arm, the straighter the vector of force. (Figures 48 and 49)**
3. **Under certain conditions, it may be necessary to incorporate more than one coil in the finger spring in order to increase the range of action. (Figure 50)**
4. **On occasion, a compensatory bend may have to be incorporated in the arm of the finger spring to avoid contact with the adjacent teeth during treatment. (Figure 51)**
5. **A simple procedure may be used to determine the position in which the coil should be placed. A line is drawn joining the present position and the desired position of the tooth being moved. A perpendicular bisector is then drawn to this line. The coil may be placed anywhere along this line, preferably as far away from the point of action as possible. (Figure 52) By following this procedure, the arm will be sufficiently long to produce a maximum range of force, and the movement of the tooth will be as straight as possible. (Figure 53)**

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2. Principles of Fixed Orthodontic Appliances

Introduction

Control of tooth movements is enhanced when appliances are fixed to the teeth. While removable orthodontic appliances can only tip teeth, fixed appliances can produce any type of tooth movement. By applying certain controlled forces to the tooth crown via the fixed appliance, apical and bodily movements, as well as rotations can be obtained. Controlled intrusion and extrusion of teeth are also possible.

As mentioned in the previous chapter, one of the reasons for the exclusive use of fixed orthodontic appliances by specialists in the United States is the strong educational influence that the "father" of modern orthodontics, Dr. Edward Angle, had not only on past clinicians but even the contemporary orthodontists.(1)(2) Dr. Angle's biggest contribution to fixed orthodontic appliance development was his advent of the "edgewise" appliance. "Edgewise" refers to the fact that a rectangular wire is placed into a rectangular bracket on the tooth with its longest dimension being horizontal, or in a facial-lingual/palatal direction. This will become more evident when the various edgewise brackets are illustrated later in this chapter. The alignment of the rectangular wire in the rectangular slot of the bracket allows for proper tooth positioning, and especially expansion of the dental arches. It must be remembered that Dr. Angle was vehemently against the extraction of teeth for orthodontic purposes, and relied solely on the expansion of the dental arches to treat any crowding that existed. It was found later, when clinicians saw the need to extract teeth during arch length-tooth mass discrepancy cases, that the heavy edgewise appliance was not very capable of closing extraction spaces efficiently.

In the 1930's, Dr. Joseph Johnson developed his "twin-wire" appliance, utilizing two light wires placed in the same bracket, thinking that two light wires would place more of a physiologic force on a tooth than would one heavy wire.[(11)] Because of the difficulty in achieving the proper tooth angulation during extraction cases, this appliance has more or less dropped out of favor by the contemporary clinician.

As fixed orthodontic appliance techniques evolved, other clinicians such as Begg[(12)], Jarabak[(13)], Tweed[(14)] and Ricketts[(15)] developed their own mechanisms to control tooth movement to their liking. It is not the scope of this text to try and explain each and every one of the fixed appliance techniques that are available to the clinician. It is only with the hope that the reader understands the basic advantages of fixed orthodontic appliances in the treatment of certain malocclusions. It must be remembered that a thorough understanding of diagnosis and treatment planning is more important than the appliance itself, since the latter is often a matter of personal preference and dictated by the educational background of the clinician.

Instrumentation

Just as there are certain instruments important for the construction of removable orthodontic appliances, there is an armamentarium of instruments with which the clinician should be familiar regarding the manipulation of fixed orthodontic appliances as well.

The Bird Beak and Three Pronged Pliers have already been discussed in the previous chapter with respect to their use for removable orthodontic appliances. These are also important pliers for the bending of wires for most fixed orthodontic appliances.

The Pin Cutter and the Hard Wire Cutter have also been illustrated for you in the previous chapter. It must be remembered that because the pin cutter is a delicate instrument, it should only be used for cutting fine wires such as ligature wires. The hard wire cutter is used for cutting all other wires, and should never be utilized intraorally.

Wire-Holding Pliers

These are often referred to as “utility pliers,” as their purpose is mostly to place and remove arch wires to and from the mouth rather then the actual bending of wires as was discussed with the bird beak and three-pronged pliers. As is the case with the wire bending pliers, it is important for the clinician to understand the correct use of the wire-holding pliers as well. The reader should also keep in mind that one wire-holding pliers may be substituted for another, as the use of these pliers is often a matter of personal preference and the educational background of the clinician.

- Howe straight pliers. (Figure 54) These pliers are used mostly for the intraoral placement and removal of labial arch wires. It can also be used to secure the arch wire to the tooth by tightening the ligature wire around the bracket.
- Howe curved pliers. (Figure 55) Because of the curvature of the beaks, these pliers are used to place the labial arch wire into the tube of the most posteriorly banded tooth. It can also be utilized to “cinch back” or bend the wire behind the molar tube to activate the arch and prevent irritation to the patient’s mucosa.
- Weingardt utility pliers. (Figure 56) The use of these pliers is similar to that of the curved Howe pliers. Because of the small and angulated beaks, these holding pliers are often the one of choice of many clinicians. As is the case of the curved Howe pliers, the Weingardt pliers are useful in the posterior segments of the dental arch.

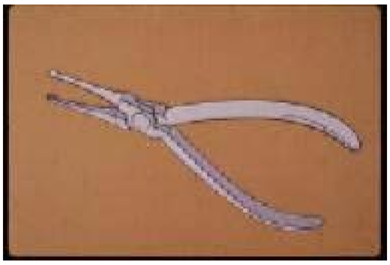

Figure 54. Straight Howe pliers.

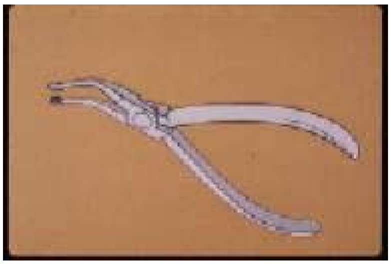

Figure 55. Howe curved pliers.

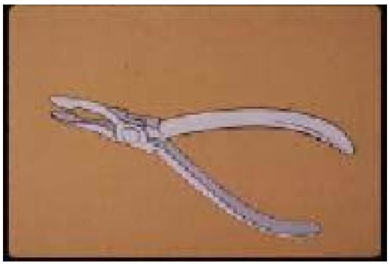

Figure 56. Weingardt utility pliers.

Banding Instruments (Figure 57)

- Band pusher (Figure 58) With a palm grip, the band pusher is used to place the preformed orthodontic bands onto the teeth. It is recommended to use the palm grip rather than a finger grip that is utilized to compact an amalgam restoration. The reason for this is that the clinician can use the thumb of the hand against an adjacent tooth for stability as the band pusher is used to place the band on the tooth. It must be remembered that the orthodontic band should fit as tight as possible on the tooth instead of relying on the cement to hold the band in place. This is termed “self retention” and prevents tooth decay from occurring inside the orthodontic band. For best results, the serrated portion of the instrument is alternately placed on the welding flanges of the welded bracket or tube and the lingual seating lug of the band. With pressure, the band is seated to the correct height on the tooth.
- Band biter (Figure 59) This device is used for much the same purpose as the band pusher. However, instead of finger and hand pressure, the patient’s biting force serves to place the orthodontic band onto the tooth. The band biter should only be utilized to place bands on posterior teeth, since the vector of the forces of occlusion in the anterior segment of the dental arch are not as vertical as those in the posterior areas. The serrated end of the instrument is alternately placed on the bracket or tube welding flanges and on the lingual seating lug, and the patient is instructed to bite gently on the plastic handle until the band is seated to the correct position.
- Band contouring pliers (Figure 60) These pliers are used to properly contour posterior orthodontic bands in order to conform the bands to the natural convexity of the premolar and molar teeth. The ball shaped beak of the pliers is placed on the inside surface of the orthodontic band, and hand pressure is used to improve the contour prior to the final placement onto the posterior tooth.
- Band removing pliers (Figure 61) These pliers are especially useful in removing orthodontic bands from posterior teeth. The author does not recommend the use of the band removing pliers on anterior teeth, especially on the lower incisors. This is because the force used during band removal could injury or even cause a fracture at the cemento-enamel junction of these rather small teeth. When using the band removing pliers, care must be taken in order not to fracture the enamel or damage the crown of the tooth. Therefore, a cotton roll should be used between the blunt-end beak of the pliers and the occlusal surface of the tooth. The greatest convexity or “under-cut” area for the maxillary posterior teeth is on the palatal surface, and on the mandibular posterior teeth the under-cut area is on the buccal surface. Therefore, the end of the other beak is placed under the buccal-gingival edge of the lower posterior bands, and under the palatal-gingival surface of the upper posterior bands. The proper beak placement of these pliers is critical because the band must be

dislodged first at the surfaces of greatest convexity or under-cut. Using gentle pressure, the handles of the pliers are squeezed together until the cement seal is broken and the band loosened from the tooth.

Figure 57. Instruments used for orthodontic banding procedures.

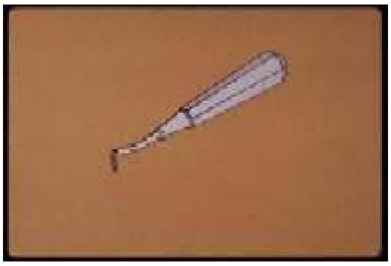

Figure 58. Band pusher.

Figure 59. Band biter.

Figure 60. Band contouring pliers.

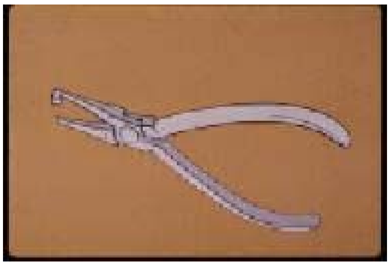

Figure 61. Band removing pliers; blunt end (top), sharp beak (bottom).

Components of Fixed Orthodontic Appliances

The principal components of fixed orthodontic appliances are:

- Bands
- Attachments, and
- Arch wires.

Bands

Orthodontics bands have a long historical evolution. Angle's original fixed orthodontic appliance consisted of bands that were made of strips of a gold alloy, formed to the tooth, "pinched," soldered, and cemented to the appropriate tooth.[3] (Figure 62) From this early period, the band material developed into strips of stainless steel, again formed to the tooth, "pinched," welded and cemented to the tooth. In the 1960's, preformed bands became widely utilized and simplified the actual orthodontic banding procedures. Direct bonding of brackets to the tooth structure was developed in the early 1970's, and many thought this would be the end to the orthodontic band.[16] However, banding is still the method of choice, especially in the posterior region of the dental arches.

A tight-fitting orthodontic band serves several purposes during the treatment of a malocclusion. First, it protects the tooth from caries. This has become more evident with the advent of bonded brackets. Because the tooth is not covered on the interproximal surfaces, more caries are found during and after orthodontic therapy with the bonded system than with treatment that is performed with well-fitted orthodontic bands. Second, an orthodontic band is utilized to place the various attachments for the application of orthodontic, and sometimes orthopedic forces. The traditional method of fixing attachments is by welding them to preformed stainless steel bands which are then cemented to the teeth with zinc-oxyphosphate or a similar cement. The cement not only helps to hold the band in place, but also prevents the formation of plaque between the band and the enamel of the tooth. The integrity of the cement should be checked at every visit because if it leaches out, serious enamel demineralization can occur rapidly. As mentioned previously, a well-formed and tight-fitting band affords a certain amount of "self retention." In other words, the clinician should not only rely on the adhesive capabilities of the cement to hold the band in place.

Band Placement

Several manufacturers supply preformed, pre-welded orthodontic bands. Generally speaking, each company's bands have different techniques for the correct placements. The following procedure is the "average" technique used in the placement of most of the bands on the market today.

1. The first step is to select a size that fits the tooth. After years of experience, this becomes more than just a "trial and error" procedure. (Figure 63) The majority of orthodontists have a specialized dental assistant helping in their offices, and it is usually this person's responsibility to select the correct band size by visualizing the tooth sizes from the patient's dental study models.
2. Although most preformed orthodontic bands are anatomically designed for each tooth in the dental arch, a certain amount of "crimping" must be performed in order for the band to conform to the circumference of the tooth. This is usually accomplished with band contouring pliers or three-pronged pliers, with the single beak placed on the inside of the band material. (Figure 64)
3. The band is tried back onto the tooth with enough force to achieve self retention. This retention is usually obtained from the "under cut" areas on the buccal/facial surfaces of the lower posterior teeth and the palatal surfaces of the uppers. The occlusal edges of the band are adapted to conform to the shape of the tooth. This "burnishing" of the band is best accomplished with a band pushing instrument for molar teeth, and an amalgum "plugger" for premolar and anterior teeth. (Figure 65)
4. posterior band should be positioned so that the occlusal portion of the band is at the level of the mesial and distal marginal ridges, and the attachment is at the middle one-third of the buccal/facial surface of the tooth (Figure 66) An important consideration for the clinician to remember is that the "k" distance is from the center of the bracket to the incisal or occlusal edge of the tooth, and it should be the same for all teeth. If this is accomplished during the banding procedure, all of the teeth will be placed into their correct positions with a "straight wire" during the final stages of orthodontic therapy.
5. In an occlusal view, the bracket should be centered on the tooth in a mesio-distal dimension. (Figure 67) This will ensure that a rotated tooth will be moved into a correct position during orthodontic treatment.

Attachments

Anything welded or soldered to an orthodontic band is termed an "attachment." These are the most important parts of the band and serve to attach the arch wires and various devices for force application. The two most common attachments are the brackets and tubes of the fixed appliance and are used for the insertion of the labial arch wires.

The type of attachments utilized in fixed orthodontic therapy depends on the type of appliance and treatment philosophy of the clinician. As mentioned previously, Dr. Edward Angle, the "father of modern orthodontics", is the person that should receive the credit for the development of the appliances used today.[1] The single most popular contemporary fixed orthodontic appliance is the "edgewise" appliance, which was developed by Dr. Angle in the 1920's.[3] The following attachments are those used in this type of mechanotherapy.

Brackets

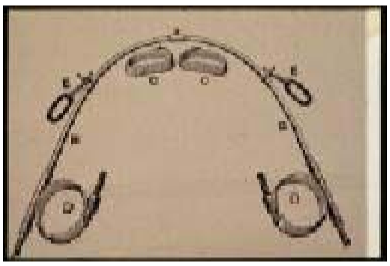

Figure 62. Dr. Angle's original fixed appliance, with strips of a gold alloy material "pinched" and soldered together to form orthodontic bands.

Figure 63. First the band should be fitted to the correct size.

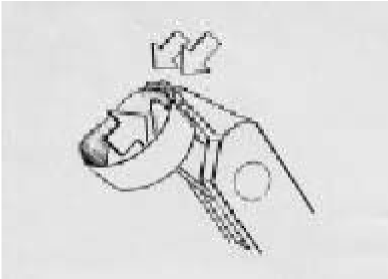

Figure 64. Crimping of the band using three-pronged pliers.

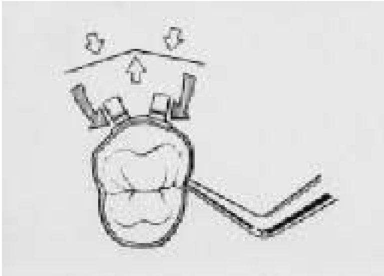

Figure 65. Adapting the band to conform to the tooth using an amalgum plugger.

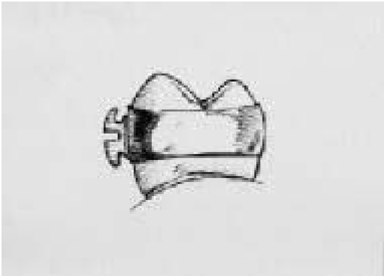

Figure 66. The occlusal edge of posterior bands should be placed at the mesial and distal marginal ridges of the teeth. The attachment should be at the middle one-third of the tooth's facial surface.

Figure 67. From an occlusal view, the bracket should be placed at the center of the mesiodistal dimension of the tooth.

Single edgewise bracket (Figure 68). The two sizes of slots used in the edgewise technique are 0.018" X 0.025" and 0.022" X 0.028". The first dimension is the gingival-occlusal/incisal measurement, and the second is the facial-lingual/palatal distance. The rectangular slot receives a rectangular wire in an "edgewise" fashion, hence the name of the bracket and technique.

The gingival-occlusal/incisal measurement is the most critical of the two, since this distance limits the size of the archwire that can be placed into the slot. Obviously, those clinicians who favor a "light wire" technique will select the 0.018" X 0.025" bracket, and those dentists who tend toward using heavier forces during orthodontic therapy will choose the 0.022" X 0.028" bracket. It is the author's opinion that one-half of the orthodontists today use the smaller bracket, and the other one-half tend toward utilizing the larger bracket. In fact, it is common to refer to one as using the "018" system, and the other clinician as using "022" mechanics. In capable hands, it does not matter which bracket is used, as long as the clinician uses appropriate mechanics that follow correct biological force systems.[10]

One disadvantage of a single bracket in the middle one third of the tooth, mesio-distally, is that it does not enable the clinician to correct for tooth rotation very efficiently. This led to the development of another type of edgewise bracket which will be explained later in this chapter.

Single edgewise bracket with vertical slot (Figure 69). This variation of the edgewise bracket is used when the technique calls for the placement of auxiliary springs through the vertical slot lingual or palatal to the bracket slot. Such springs can be used to upright and tip teeth in various directions. This is a common bracket utilized by Dr. Broussard in his technique which uses various vertical auxiliaries to retract and upright teeth for closing mechanics after the extraction of premolars.[17]

Single edgewise bracket with vertical slot and narrow ligature slot (Figure 70). This variation of the vertical slot bracket also has a ligature slot in case the clinician desires to tie the arch wire to the mesial or distal portion of the bracket. This technique would help to achieve rotation of a tooth, which is an advantage over the single edgewise bracket previously described.

Single edgewise bracket with vertical slot and wide ligature slot (Figure 71). This variation of the previous bracket has a wider ligature slot to facilitate the mesial or distal rotation of a tooth. In order to rotate the tooth mesially or distally, the clinician would tie the arch wire only to the ligature slot on the side of the tooth that is rotated toward the lingual or palatal side of the dental arch in order to pull that side of the tooth toward the facial surface.

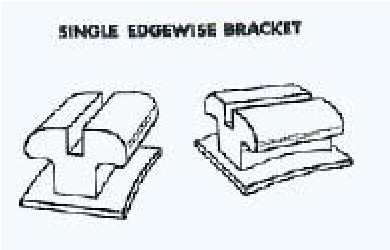

Figure 68. Single edgewise bracket.

Figure 69. Single edgewise bracket with vertical slot.

Figure 70. Single edgewise bracket with vertical slot and narrow ligature slot.

Twin edgewise bracket with vertical slot (Figure 72). The previous bracket led to the development of the "twin bracket" which is the most common one used today by orthodontic specialists. This bracket is a variation of the single bracket as well as the one with ligature slots. Instead of a ligature slot, there are two distinct bracket "wings" for easier rotation adjustments. Depending on the type of rotation, the arch wire is tied to one or the other wing in order to properly rotate the tooth.

Bonding of Brackets

Traditionally, brackets were soldered or welded onto orthodontic bands, and the bands were then cemented to the teeth. The usual manner now is to bond the brackets, especially in the anterior segments of the dental arch, directly to the teeth with various acrylic bonding systems.

The first attempt of bonding brackets or other attachments to tooth structure was by the use of various types of copper cement as the adhesive. Although copper cements afforded more adhesion than typical zinc phosphate cements, most attempts to use this material for bonding purposes failed. It was in the early 1970's that our colleagues from Japan developed a true bonding system for orthodontics that is almost universally used today to bond brackets to anterior teeth.(16) The reason why bonding should be limited to anterior teeth is because the forces of the posterior occlusion have a tendency to dislodge posteriorly bonded brackets. Preformed orthodontic bands with prewelded attachments are still the method of choice in the posterior segments of the dental arch. The author does not feel it is necessary to delve into a step-by-step bonding procedure for orthodontic puposes. The general dentist knows this system well, since the steps for bonding orthodontic brackets are similiar to the technique used to bond restoration materials to enamel. (Figures 73 and 74)

Tubes (Figure 75)

The other attachments soldered or welded on orthodontic bands are molar tubes, on the last molar banded, which is usually the first permanent molar. In certain circumstances, the second permanent molars are also banded. Then, these are the teeth whose bands receive the tubes, and all of the preceding teeth, including the first permanent molars have brackets soldered or welded to their bands. In other words, the most posterior teeth on which bands are placed receive the tubes, and all other teeth have brackets as attachments.

Maxillary Tubes

There are two or three tubes placed on the upper molar band. One is for the insertion of the head gear, and another one or two tubes for placement of the labial arch wire/s.

Head gear tube. This is a round tube, and the diameter is usually 0.045", the size of the inner bow of the head gear. It can either be placed gingival or occlusal to the arch wire tubes.

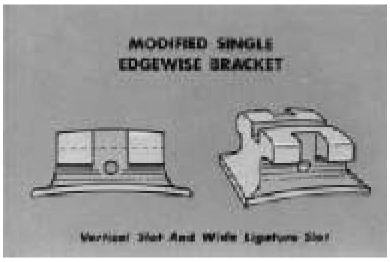

Figure 71. Single edgewise bracket with vertical slot and wide ligature slot.

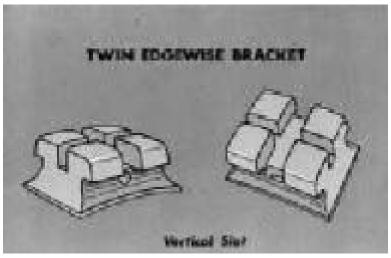

Figure 72. Twin edgewise bracket with vertical slot.

Figure 73. Etching of enamel prior to bonding bracket.

Figure 74. Brackets bonded to upper anterior teeth..

Figure 75. Tubes attached to the last upper and lower molar bands are of similar size as the brackets.

Figure 76. Hooks soldered on molar bands used to attach elastics for inter-maxillary traction.

Placing it gingival causes the molar to tip less than placing it toward the occlusal, when the forces of the head gear act on the tooth. On the other hand, placing the head gear tube toward the occlusal allows the patient an easier access for the placement of the headgear.

Arch wire tubes. **Depending on the technique, there are either one or two arch wire tubes. These are rectangular, and are the same size as the brackets used in the edgewise appliance (0.018" X 0.025" or 0.022" X 0.028")**

Mandibular Tubes

Arch wire tubes. As seen on the upper, there are either one or two arch wire tubes on the lower molar band as well. Again, the tubes are rectangular, and are the same size as the brackets used in the edgewise appliance.

Auxiliaries

Occasionally, there may be another attachment on the molar band. There may be a ball or hook on the facial surface of the band for the placement of intermaxillary elastics during the treatment of Class II or Class III malocclusions. (Figure 76) Also, a hook or ball may be soldered or welding onto the palatal surface of the upper molar band for the attachment of elastics during the treatment of posterior cross bites.

Orthodontic Wires

Requirements of Orthodontic Wires

- **Non-corrosive**
- **Easily formed**
- **Maintain shape**
- **Controlled and reproducible force delivery**

From the outline above, one can see what the requirements are of an ideal wire material for orthodontic purposes. All orthodontic wires are made from an alloy, which is defined as “any combination of two or more metals.”

Historically, the types of wires that have been used for orthodontic purposes have been:

- Gold
- Stainless steel
- Cobalt-chromium-nickel
- Nickel-titanium

Gold alloy was the first material used in orthodontics. It was ideal as far as its ease of manipulation, and it could be “heat-treated” in order for it to maintain its shape and produce a controlled force delivery system. However, gold is very corrosive in the oral cavity, and its cost now makes this material prohibitive for use in orthodontic treatment.

Stainless steel alloy has been the material that has been traditionally used in modern orthodontics. It is relatively easy to manipulate, it is non-corrosive in the oral cavity, and it is capable of an effective controlled force delivery system.

Cobalt-chromium-nickel alloy wires have the same ideal characteristics of the gold alloy wires that were once popular in orthodontics. They are very malleable, they can be heat-treated to be capable of delivering effective forces, and they have the advantage over gold of not being corrosive in the oral cavity.

The nickel-titanium wire alloy can be considered a “space age” material. Its commercial name is “Nitinol” wire and derives its name from the first two letters of the words nickel and titanium, and “nol” standing for the Naval Observatory Laboratory where this alloy was first developed. “Ni-Ti” wires have the advantage of being very “springy.” In other words, they are capable of bending a large distance without becoming permanently deformed. These are ideal wires to use during the initial stages of orthodontic treatment when light round wires of this material are used for the initial stages of therapy.

Shapes of Orthodontic Wires

Round wires are most commonly used at the outset of orthodontic treatment for such things as “leveling” the arch and tooth rotation.(Figure 77) As mentioned in the previous chapter, the size of these wires is designated by the diameter of the wire in inches. Usually, smaller wires are used first, followed by larger wires, depending on the tooth movement desired and the size of the brackets and tubes used in the appliance. The sizes of round orthodontic wires used in fixed appliance therapy range from 0.014" to 0.022". The size of the brackets and tubes that the clinician utilizes will determine the largest wire that can be used during treatment. The inner bow of the head gear is also a round wire, and its size is usually 0.045". Lingual arches, such as those used for space maintainers or retainers, are made from round wires, the size usually being 0.040.”(Figure 78)

Rectangular wires are used after round wires during the treatment of a typical malocclusion. (Figure 79) The wires fit into the rectangular brackets and tubes in an “edgewise” fashion, and allow the clinician to control the movement of the tooth in all planes of space. (Figures 80 and 81) The size of rectangular wires vary greatly, and are too numerous to discuss. A typical rectangular wire is 0.016" X 0.022,” the first measurement being the incisal/occlusal-gingival dimension, and the second being the facial- lingual/palatal dimension. There is a direct correlation between the size of the arch wires and the force transferred to the teeth.

Segmented or Sectional Wires

Aside from using a continuous wire on the facial side of the dental arches from one last permanent tooth to the other, a segmented or sectional wire can also be used in certain circumstances. (Figure 82) This is especially true in fixed orthodontic cases treated by a general practitioner when only a limited number of teeth need to be moved.

Ligature Wires

Once the band is placed and cemented properly to the tooth, the labial arch wire is ligated to the bracket using a “dead-soft” stainless steel wire of 0.009 to 0.011 inches in diameter. The purpose of the ligation is to secure the wire to the bracket so that the proper forces can act on the tooth. (Figures 83-85) Another method of securing the arch wire to the bracket is with elastic modules called “alastics.” (Figure 86) This is usually done during the final stages of treatment, or when significant forces are not required to move a tooth, because the rubber material of the elastic modules has a tendency to stretch and lose its effectiveness.

Figure 77. Upper and lower round arch wires used for initial stages of treatment.

Figure 78. Lingual arch used for retention.

Figure 79. Rectangular arch wires used for later stages of treatment.

Figure 80. A mesial tipping force (left) is placed on an upper left central incisor by torquing the wire in a clockwise direction. A straight wire produces the same movement on a malposed tooth (insert) as long as the bracket is positioned correctly on the tooth and the wire is not permanently deformed.

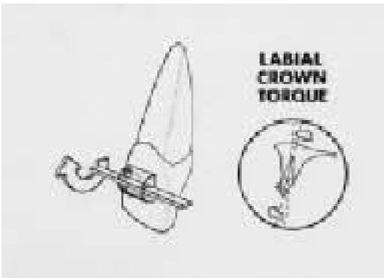

Figure 81. A rectangular wire is adjusted in the direction of the arrow (left) in order to produce labial crown torque. Insert shows the direction of the tooth movement. As the crown is torqued in a labial direction, the root moves toward the palate.

Figure 82.Upper and lower segmented or sectional arch wires.

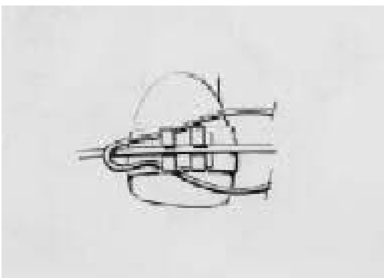

Figure 83. The looped ligature wire is placed so that the “lead” portion is outside the arch wire.

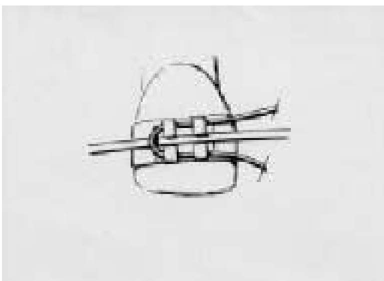

Figure 84. The incisal and gingival portion of the ligature wire are tucked under the corresponding parts of one bracket.

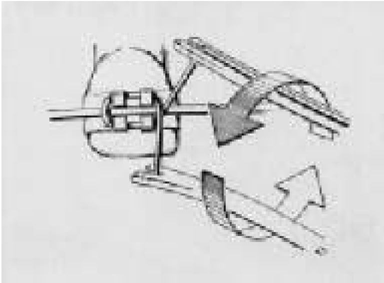

Figure 85. The tails of the ligature are brought together, and the tie is begun; in this case they are turned in a counter-clockwise direction. The tail is continued so enough wire is available to cut and tuck under the arch wire.

Figure 86. Elastic modules used to secure the arch wire to the brackets.

Figure 87. Elastic therapy to treat a posterior cross bite.

Figure 88. Headgear to reinforce achorage of upper molars.

Anchorage

We learned in the previous chapter that removable orthodontic appliances require a certain amount of anchorage for proper retention. Anchorage for fixed appliance therapy is an entirely different concept. It means "the nature and degree of resistance to displacement offered by an anatomic unit when used for the purpose of tooth movement." In simple terms, when a force is placed on a tooth, there is an "equal and opposite" force created. It is easy to understand when one thinks about a reciprocal force between two teeth, as is the case when a simple cross bite is treated using elastic therapy. (Figure 87) As in this example, a clinician would want these two teeth to move "reciprocally." In other cases, the dentist may want to "reinforce" the anchorage value of a tooth that he or she would like to remain stationary. A lingual holding arch, described previously, is one example of reinforcing the mandibular molars when the clinician does not want them to move forward. In the maxilla, two methods of choice are the headgear (Figure 88) and the palatal holding arch (Figure 89) to hold the maxillary molars in place while retracting anterior teeth. An entire chapter could be devoted to this important topic, but the author believes that if the clinician understands the above description of anchorage, he or she should be able to use this philosophy to his or her advantage during limited fixed orthodontic therapy.

Figure 89. Nance palatal holding arch to reinforce anchorage.

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3. Interceptive and Limited Orthodontic Techniques

Introduction

Prior to any discussion of interceptive orthodontic treatment, one must have a clear understanding of the general objectives of early orthodontic therapy. It was not too long ago that most clinicians waited until the permanent dentition had erupted before instituting orthodontic therapy. However, the dentist began to realize that most of their patients' pre-pubertal growth had already taken place, and that orthopedic correction of any skeletal disharmonies was almost impossible to correct.(10) Also, leeway space, which is the difference in width between the deciduous molars and the smaller permanent premolars, could not be utilized after the exfoliation of the deciduous teeth, and any minor anterior crowding that existed could not be easily treated without saving this critical space. (18)(19) These and other considerations almost compelled the clinician to begin treating early, at least during the "mixed dentition."

Objectives of Early Orthodontic Treatment

The objectives of early orthodontic treatment are as follows:

1. Attain genetic growth potential
2. Establish normal relationships
3. Remove functional interferences
4. Maintain normal function
5. Allow for the normal eruptive sequence

Attain Genetic Growth Potential

A pioneer in orthodontics, a student of Dr. Angle's and a long-time professor at the University of Illinois, Dr. Alan Brodie, stated that a child's facial growth pattern is established early in life, as early as the fourth month of age, and once established, the growth pattern of the individual can be easily predicted unless it is upset by some extrinsic factors.(20) In other words, the dental profession was told about growth prediction as far back as l94l. Once knowing what a child's growth pattern is, and if it is deemed unsatisfactory, the clinician can utilize certain orthopedic devices, such as a headgear, to redirect the growth of the jaws to a more harmonious relationship. Therefore, it is dependent on the clinician to help the patient attain his or her growth potential with early orthodontic intervention.

Establish Normal Relationships

Teeth can be moved at any age, but there is only a short period during the age of a growing patient that a clinician can effect the growth of the jaws in order to obtain a normal maxillo-mandibular relationship. In other words, the spatial relationship between the jaws is the most important orthodontic treatment objective, no matter what the age of the patient. Whatever severe skeletal discrepancies are not treated with orthopedics during growth usually have to be corrected surgically in the patient's adult dentition.

In a classic article in 1967, Dr. T. M. Graber and associates, explained to the dental profession the important differences between orthodontic and orthopedic forces, and it is the role of the clinician to utilize this information in order to treat his or her patient correctly.(21)

Remove Functional Interferences

There are certain extrinsic factors that create functional interferences during growth. Such habits as thumb sucking and mouth breathing can create a narrow maxilla, when compared to the mandible, thus causing the lower jaw to deviate to one side or the other during occlusion. These types of functional interferences must be treated early, or the patient may suffer from various growth discrepancies of the jaws, or abnormal temporo-mandibular joint disfunctions. (22)

Maintain Normal Function

Before the clinician can hope to maintain normal function, he or she must know the difference between what is normal and what is abnormal for every stage of dental development. What may be normal at one age, may very well be abnormal for another age. The dentist must know the difference between "transient" and "incipient" malocclusions. Examples of the former are the aforementioned "ugly duckling" stage of dental development, the "end-to-end" or

“flush terminal plane” relationship of the permanent molars in the “mixed dentition,” and the lingual eruption of the lower permanent incisor teeth. These examples are “normal” malocclusions at a particular age, and should be allowed to develop naturally without any orthodontic intervention. On the other hand, if the clinician sees that the patient is developing an “incipient” malocclusion, or one which is abnormal for a given age, then it is the dentist’s responsibility to intercept this malocclusion before it worsens.

Allow for the Normal Eruptive Sequence

As described previously, there is a certain eruptive sequence of the permanent teeth that should occur, which is different between the two jaws.[10] It is not so important that the patient follows his or her “calendric” development, as long as the permanent teeth are erupting in correct sequence. It is important to remember also that if a permanent tooth is erupting on one side of the dental arch, its “mirror image” tooth on the other side should also show evidence of eruption. If this does not occur, then the dentist should look for such problems as overly retained deciduous teeth, or even the congenital absence of permanent teeth.

Examples for Early Orthodontic Treatment

There are three basic types of orthodontic treatment, namely, preventive, interceptive and corrective therapy.[10] The latter is mostly concerned with the permanent dentition where it is too late to institute preventive and interceptive procedures. Preventive orthodontics implies those procedures which the clinician can accomplish that would eliminate treatment in the future. Examples of these are: correct interproximal tooth restorations, timely exfoliation of primary teeth, and eliminating any extrinsic factors such as habits and mouth breathing which have an effect on the normal growth and development of the jaws.

Interceptive orthodontics is perhaps the most important procedure that a general dentist can perform in his or her important role as the “watch dog” of the dental profession. It is up to the clinician to differentially diagnose those cases that require proper interceptive procedures that can be readily treated by the general dentist, and to properly refer those cases to a specialist that require more intensive therapy. In other words, the dentist should be able to differentiate the “easy” cases from the “difficult” ones, and try and concentrate on the former. Examples of interceptive orthodontics are: orthopedic guidance of developing skeletal malocclusions such as Class II division I, Class II division 2 and Class III discrepancies. Certain anterior open bite malocclusions also fall into this category. However, the types of patients that usually can be treated very successfully by the dentist using interceptive procedures are those that have developed certain problems due to prolonged habits such as thumb sucking, as well as problems caused by extensive mouth breathing.

Thumb Sucking

Dentists and parents have always been concerned with the psychological and physiological effects of infantile intraoral habits such as thumb sucking.[22] What causes some children to suck their thumb and others to completely ignore this digit? Is this a normal response or one that is garnished with present and future psychological problems? What types of physiological problems do thumb sucking cause, and are the results of this habit temporary or permanent? At what age should a “normal” child cease sucking his or her thumb? Should parents discourage their off-spring from any oral habits? What methods should be used to discourage the continuance of prolonged thumb sucking habits? Is professional help needed to do this, and if so, what kind? A psychiatrist? A pediatrician? A children’s dentist? A general dentist? An orthodontist?

To begin with, the “hand-to-mouth” cycle is normal for infants, and any attempt by parents to prevent their child from the inherent satisfaction that their child derives from this “habit” will create more harm than good. (Figure 90) Generally speaking, any intra-oral damage that most thumb sucking habits create is temporary and effects only the anterior portions of the jaws. Any interruption of normal development that this habit may create, however, depends on the so-called “trident of habit factors”.

Trident of Habit Factors

- **Duration**
- **Intensity**
- **Frequency**

If a child sucks his or her thumb all day long, with a great deal of intensity, and especially if the habit is a prolonged one, the damage to the jaws can be permanent and affect even the posterior segments of the occlusion.

The greatest effect of a prolonged thumb sucking habit is to the anterior segment of the dental arch. The thumb protrudes the upper anterior teeth, and forces the lower anteriors lingually. An anterior open bite is created, and tongue thrusting develops in order for the patient to form an anterior seal during deglutition. The aforementioned signs are often referred to as a “thumb sucking malocclusion.” (Figure 91) If the habit is broken prior to 3 1/2 to 4 1/2 years of age, the above discrepancies are usually temporary. However, if the habit is allowed to progress past this age range, and especially if it is occurring concurrently with the eruption of the permanent incisor teeth, the damage can become more permanent, and may create a skeletal open bite as well as a Class II maxillo-mandibular relationship.

It is usually futile and unwise for a parent to force a child to stop a prolonged thumb sucking habit. Perhaps more harm than good can arise from this unwarranted discipline of the child. In most cases, some type of fixed appliance therapy by the dentist is required to help the patient in his or her first attempt in life at breaking a “bad habit.” (Figures 92 and 93) The optimal time for appliance placement is between the ages of 3 1/2 and 4 1/2 years, preferably during the spring or summer when the child’s health is at its peak, and sucking desires can be sublimated in outdoor play and social activities.

The “tongue crib” appliance serves several purposes. First, it renders the finger habit meaningless by breaking the suction that is created by the close proximity of the thumb and the hard palate. The child may place his or her finger in the mouth, but he or she gets no real satisfaction from it. Second, by virtue of its construction, the appliance prevents finger pressure from displacing the maxillary incisors further labially, creating more damage and causing a greater likelihood of abnormal tongue and lip function.

Third, the appliance forces the tongue backward, or at least prevents the tongue from thrusting between the upper and lower incisors in order to form a seal during the act of deglutition. If the patients are normal, healthy children, no unfavorable results are observed except for a temporary sibilant speech defect when the appliance is first placed, but disappears in a very short time.

Figure 90. In-utero view of “early” thumb sucking pattern.

Figure 91. “Thumb sucking malocclusion” includes spacing, anterior open bite and spacing, protrusion of upper incisors and reclining lower incisors.

Figures 94 through 96 illustrate a case that was originally misdiagnosed as a Class II skeletal open bite. After a thorough cephalometric diagnosis and patient history, it was determined that the patient had a typical thumb sucking malocclusion. This case was treated in a short period of time, about 4 to 6 months, with a single tongue crib appliance. Once the thumb habit was cured, the patient’s occlusion reverted to her hereditarily predetermined morphogenetic pattern, which was normal.

The real danger from a prolonged thumb sucking habit is the possible change to the occlusion, sufficient to allow the potent buccinator muscle forces to create a full-fledged malocclusion. It is these perverted forces that create the unilateral and bilateral crossbites so often associated with finger-sucking habits. (Figure 97) It must be kept in mind that the two halves of the maxilla are actively growing in width during the adolescent stages at which time thumb sucking habits are occurring. There is a discrepancy in width between the maxillary and mandibular dentition, and because of the narrowing of the maxillary arch, the patient is forced to shift the mandible to the left or right in order to create a “functional occlusion.” In other words, what appears to be a unilateral crossbite is in essence a bilateral problem. (Figure 98)

In this type of situation, an appliance should be designed to not only widen the buccal segments of the maxillary dental arch, but also to create a physiologic orthopedic force in order to position the two bones of the maxilla in a more normal relationship. It is the author’s opinion that the most “physiologic” appliance to use at this particular stage of growth and development is the quad helix appliance. (Figure 99) This appliance derives its name from the four helices that are incorporated in the 0.040" palatal wire prior to it being soldered to the bands that are eventually cemented to the maxillary second deciduous molars. The appliance is activated, or widened, a total of 8 millimeters prior to cementation. (Figure 100) Research by the author has determined that this amount of activation is sufficient to create an orthopedic effect on the developing maxilla and to treat most cross bites created by prolonged thumb sucking habits.[23]

Figure 92. "Personalized" tongue crib.

Figure 93. Palatal view of tongue crib.

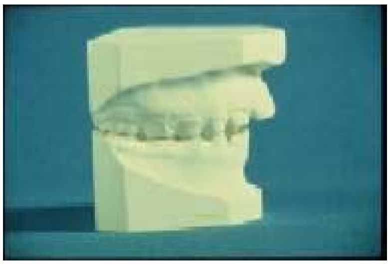

Figure 94. Side view of "thumb sucking malocclusion." Note maxillary incisor protrusion and anterior open bite.

Figure 95. Palatal view of tongue crib used to treat prolonged thumb sucking and malocclusion.

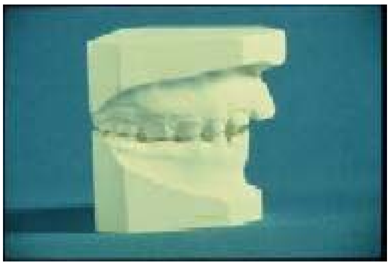

Figure 96. Models of occlusion treated with tongue crib.

Figure 97. Apparent unilateral cross bite. Note the lower midline shift to patient's left. This is a sign of a bilateral problem.

Functional malocclusions should be treated as soon as they are seen in order to create the proper environment for the future development of the dentition. (Figure 101) This is a good example of performing a correct differential diagnosis of a transient malocclusion, which "treats itself" by normal growth and development, and an incipient malocclusion, which needs early intervention, such as the treatment of a functional malocclusion.[10] If this is not done, a functional malocclusion could develop into a more serious skeletal problem.

Fixed habit breaking tongue cribs are usually the method of choice, because they do not require patient compliance. If the patient is extremely motivated and cooperative, the clinician may attempt to utilize a tongue crib embedded into a modified Hawley type of removable orthodontic appliance. (Figure 102)

Deglutition

When a newborn infant attempts to swallow, he or she must thrust the tongue forward in order to create a seal for deglutition. (Figure 103) This is called "infantile" or "visceral" swallowing. As teeth erupt, the proximity of the anterior teeth act to create the seal for swallowing in the adult patient. (Figure 104) This is called "somatic" swallowing. If there is an anterior open bite and the front teeth are not able to approximate, the patient must then thrust the tongue forward in order to swallow, just as an infant does. (Figure 105) Since an average person swallows 900 to 1100 times per day, tongue thrusting can aggravate the anterior open bite problem. There are only a few circumstances in which the tongue causes the open bite syndrome, such as when a true macroglossia can affect the intraoral structures. (Figure 106) Generally speaking, the treatment described for a prolonged thumb sucking habit is usually the therapy of choice for tongue thrusting, unless the latter is due to an abnormal skeletal problem, which then needs extensive mechanotherapy. (Figure 107)

It is often thought that tongue thrusting is caused by the lack of breast-feeding of an infant. In other words, children that are extensively bottle-fed, the older nipples had too large of an opening, and the infant had to thrust his or her tongue forward to stop the excessive flow of milk. True or not, the manufacturers of artificial nipples altered the design to have smaller openings and more anatomically shaped.

The hyoid bone is often termed the "skeleton of the tongue." This is because the supra-hyoid muscles extend from the base of the tongue to the hyoid bone. In a normal situation, the hyoid bone is found to be at a level between the third and fourth cervical vertebrae as seen on a lateral cephalometric radiograph. (Figure 108) If the patient has a true tongue thrusting problem, the hyoid bone will be found in a superior position, indicating to the clinician that more extensive therapy may be needed for this type of a patient. Often times, orthodontists will refer their tongue thrusting patients to a speech therapist, who will instruct the patient on proper swallowing and tongue position.

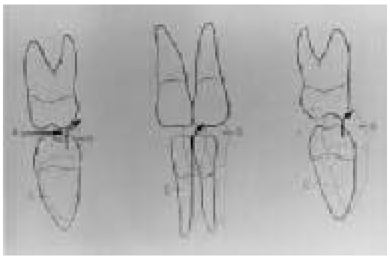

Figure 98. Diagram showing the unilateral cross bite B), but when the midlines are aligned C), it is actually a bilateral cross bite. A) shows the mandibular shift to the patient's left creating the "functional" malocclusion.

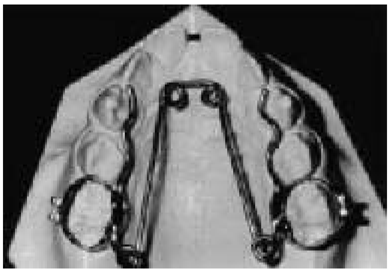

Figure 99. Quad helix appliance to treat narrow maxilla caused by prolonged thumb sucking habit.

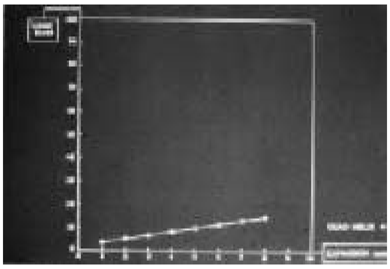

Figure 100. Graph showing how 8mm of activation of the quad helix creates about 15 ounces of force, sufficient for widening the maxillary complex in children.

Figure 101. After about four months of treatment with the quad helix appliance. Note the midlines.

Figure 102. Tongue crib embedded in the palatal acrylic of a removable appliance.

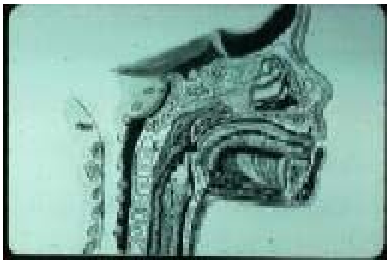

Figure 103. Sagittal view of newborn infant illustrating a tongue thrust across the edentulous dental pads during swallowing.

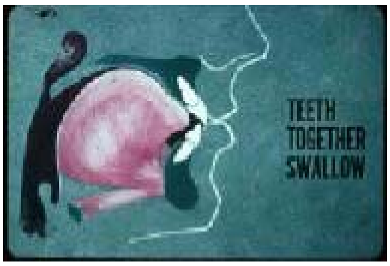

Figure 104. As the teeth erupt and come together in the anterior region the incisors and canines form the necessary seal for deglutition.

Figure 105. An anterior open bite allows the tongue to come forward each time the patient swallows.

Figure 106. Skeletal open bite caused by macroglossia as a result of a lymphangioma of the tongue.

Figure 107. Tongue crib for the treatment of tongue thrusting.

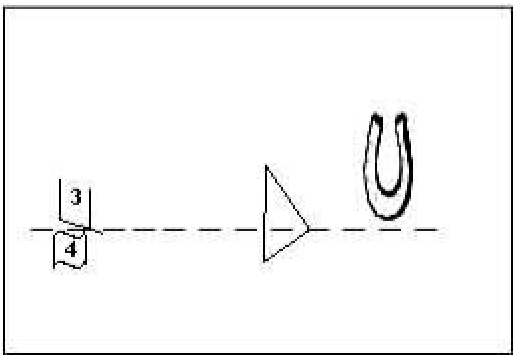

Figure 108. Normal position of hyoid bone.

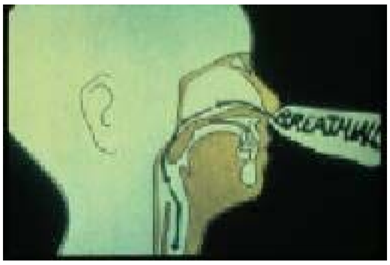

Figure 109. Nasal breathing warms, moistens and filters the air and allows for normal growth of jaws.

Mouth Breathing

Nasal breathing is important, not only for health reasons, but also for the normal growth and development of the craniofacial complex. (Figure 109) The nose acts as a filter to clean, warm and moisten the air before entering the lungs. Mouth breathing does not allow the normal development of the maxilla because of the lateral pressure produced by the buccinator muscles on the upper jaw structure. Also, because the mandible is kept open during mouth breathing, there is a tendency for the posterior teeth to supra-erupt causing an open bite and an increase in the vertical dimension of the patient. In the early 1900's Angle wrote about the importance of the nasal airway, and showed illustrations of various patients that he termed had a "mouth breathing syndrome."[(24)] (Figure 110)

Adenoids

One problem that is definitely associated with tongue thrusting and mouth breathing is the proliferation of adenoid tissue. The normal nasopharynx includes the posterior wall of the nasal pharynx and the superior surface of the soft palate. (Figure 111) The normal "velo-pharyngeal" closure occurs between the nasal pharynx and the soft palate each time the patient swallows and speaks certain sounds. (Figure 112) The adenoid tissue is found at the posterior wall of the nasal pharynx and if proliferated, it can cause a blockage of the normally patent nasal airway. (Figure 113) This prohibits normal nasal breathing by the patient, encourages mouth breathing, and produces a malocclusion similar to that found in thumb sucking and tongue thrusting patients. In severe cases, not only does mouth breathing cause a narrowing of the maxilla, but it can interrupt the normal forward development of the mandible. (Figure 114) This is a perfect example of an extrinsic etiologic factor causing a malocclusion to develop, and is considered to be a major factor, even more important than intrinsic causes.

The treatment of proliferated adenoids is extremely controversial. Most physicians are reluctant to indiscriminately prescribe adenoidectomy, since lymph tissues act as an important defense mechanism for the body. Nevertheless, the dentist should consult with a physician to discuss the possibility of at least a partial adenoidectomy in severe cases that produce skeletal types of malocclusion. It is often incumbent upon the dentist to help instruct our medical colleagues about the importance of a patent airway and the role that hypertrophied adenoid tissues play in the underdevelopment of the maxillo-mandibular complex. It certainly aided the author's relationship with his otolaryngology colleagues when he spoke to them several years ago about this important topic. It also helped our medical counterparts when research was performed to objectively determine the space available for proper nasal breathing using cephalometric analyses.[(25)]

Figure 110. "Mouth breathing syndrome" as illustrated by Dr. Angle.

Figure 111. Nasopharynx. Note posterior wall of the nasal pharynx, where adenoid tissue is located, and the superior surface of the soft palate.

Figure 112. Normal velopharyngeal closure.

Figure 113. Lateral cephalometric view of proliferated adenoid tissue. Note small airway and malocclusion associated with mouth breathing.

Figure 114. Mouth breathing patient with anterior open bite and narrow maxilla.

Figure 115. Frontal view is best to measure width of nasal cavities.

Since proliferated adenoid tissue can cause a tongue thrust due to an attempt by the patient to open the oral pharynx, the dentist should never place a tongue crib in cases of hypertrophied intra-oral lymph tissues. A patent airway is crucial prior to any type of orthodontic appliance therapy.

Nasal Cavities

Beside the pharynx, it is critical for the nasal cavities to also be patent for the patient to breathe through his or her nose. As mentioned previously, the nose warms, filters, and moistens the air prior to passage into the lungs. Therefore, the nose plays an important role other than just "cosmetics." A deviated septum and hypertrophied turbinates may block the nasal cavities and cause mouth breathing. It is critical for the dentist to evaluate this area of breathing as well. There is no better way to diagnose true nasal breathing problems than to utilize a frontal cephalometric radiograph. (Figure 115) This view allows the clinician to evaluate the width of the nasal cavities and to denote any deviation of the nasal septum. Blockage of the nasal cavities is the most common reason for mouth breathing in adult patients, and surgical intervention by an otolaryngologist is a relatively easy procedure to correct this problem.

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4. Limited Corrective Orthodontic Techniques

Anterior Space Closure

Spacing between the anterior teeth may be caused by a variety of factors. The upper incisor teeth may be protruded due to a hyperactive tongue, hypotonic perioral musculature, discrepancies between tooth size and dental arch length, an abnormally large frenum, or ectopic tooth eruption.

Several types of orthodontic appliances may be utilized in the treatment of protruded anterior teeth, one of which is a removable appliance utilizing elastic traction. Elastic therapy or forces generated by the activation of labial wires can be used with removable appliance techniques, depending on whether a continuous or an intermittent force is desired. Either technique is satisfactory, as long as the forces are within the limits necessary for efficient tooth movement.

A light elastic is often attached between two hooks situated on the labial surface of the canine teeth (Figure 116) The elastic should be relatively light, producing no more than 3 1/2 ounces of force at maximum activation. Generally speaking, the elastic will produce the force established by the manufacturer when it is stretched to two times the original diameter of the lumen.(26) (Figure 117) The patient is supplied with sufficient elastics to last for two weeks, during which time they are replaced every one or two days.

Care must be taken not to remove an excessive amount of palatal acrylic behind the anterior teeth during treatment, since it may cause tissue irritation as the gingiva is pinched between the moving teeth and acrylic. (Figure 118) Therefore, no more than 1 to 2 millimeters of acrylic should be removed in any one visit in order to prevent this complication from occurring. (Figure 119) Prior to fabricating the removable orthodontic appliance, it is advisable to place a small amount of wax palatal or lingual to the anterior teeth to be moved. (Figure 120) This will allow enough space for the teeth to move distally without impinging on the palatal or lingual tissue.

Figure 116. Labial elastic used to retracted upper incisors.

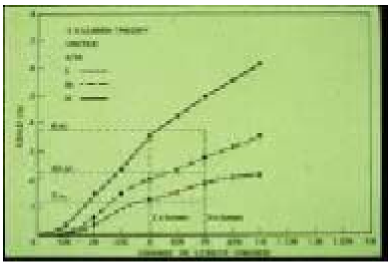
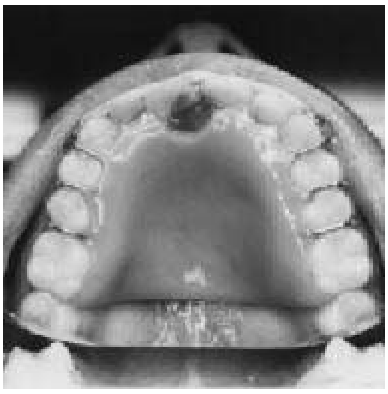


Figure 117. Graph shows how required force is produced when elastics are stretched to two times their original lumen size.



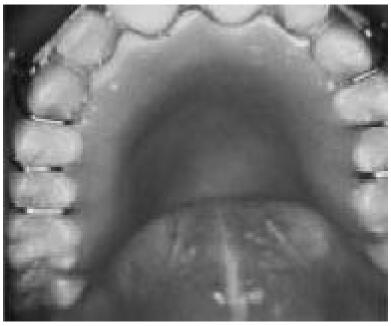


Figure 118. When excessive palatal acrylic is removed, gingiva is pinched as teeth move causing irritation.

Figure 119. Only a small amount of palatal acrylic should be removed prior to activation.

Figure 120. Prior to fabricating the appliance, place wax palatal to the anterior teeth.

Midline Diastema Closure

A controversy sometimes arises as to what causes a midline diastema, or the space between the maxillary central incisors. Some say that the pressure of a labial frenum produces a diastema, while others report that the frenum is present because the incisors have not come together to produce sufficient pressure for resorption.

Some spacing is normal prior to the eruption of the permanent canines. This is the transient malocclusion referred to as the "ugly duckling" stage of dental development.(27) As described previously, when the canines erupt the pressure of eruption causes an autonomous uprighting of the lateral incisors, space closure, and frenum resorption.(10) Therefore, if sufficient space is present for the permanent canines, any anterior space closure should be minimal or postponed until after these teeth erupt. If overzealous treatment is performed too early, there is a possibility of incisor root resorption or distal deflection of the canine teeth from their normal path of eruption.

If the teeth adjacent to the diastema are parallel, or if the crowns are tipped toward the space, then a banded approach with a segmented or sectional arch wire is necessary. (Figures 121 & 122) The wire helps to upright the teeth and moves the crowns together so that the teeth parallel each other. This will prevent relapse and periodontal problems.

An "active" Hawley type of removable orthodontic appliance, either with a labial wire or an elastic, may also be utilized to aid in the closure of a diastema. By the term "active," the author wants to differentiate this tooth-moving Hawley appliance from the "passive" Hawley appliance which retains the teeth after orthodontic therapy. If there is also anterior protrusion of the incisors, causing an excessive incisor horizontal overlap ("overjet"), activation of the Hawley appliance will move the incisors palatally.

Figures 123 and 124 illustrate a case where there was a diastema between the maxillary central incisors, along with protrusion of these two teeth. An active Hawley appliance was utilized to retract the teeth toward the palate, and helical loop springs were activated to move the teeth mesially to close the midline diastema, and to open sufficient space for the eruption of the permanent upper lateral incisors.

Figure 125 shows a similar case of maxillary incisor protrusion with a maxillary midline diastema. The protrusion, however, was more severe than the previously shown case, and a Hawley removable orthodontic appliance was activated to retract the maxillary central incisors. Figure 126 illustrates an auxiliary spring soldered to the labial wire of the Hawley appliance in order to guide the maxillary right lateral incisor along its proper path of eruption. Figure 127 shows the labial "bulge" of the erupting maxillary left lateral incisor. Another auxiliary spring was eventually soldered to the Hawley labial wire to perform the same tooth guidance that was used on the maxillary right lateral incisor. This case is a good example of limited interceptive and corrective orthodontic therapy to treat an "incipient" malocclusion.

Figure 121. Closing an anterior diastema with a limited banding technique. Sectional arch wire with elastic therapy.

Figure 122. Sectional wire moves teeth together in a parallel manner.

Figure 123. Incisor protrusion with midline diastema.

Figure 124. Hawley appliance with helical loop springs retracted incisors and closed diastema.

Figure 125. Central incisors protruded with diastema prior to eruption of lateral incisors.

Figure 126. Auxiliary spring soldered to labial wire to guide the eruption of upper right lateral incisor.

It is important for the clinician to be cognizant of the sequence of eruption of the permanent teeth, especially the canines and premolars, and how it differs between the maxillary and mandibular dental arches.(10) As a review, the canines erupt after the first and second premolars in the maxillary dental arch, but prior to the premolars in the mandibular dentition. This is the reason why the canines are more likely to be impacted in the upper dental arch, and why the second premolars are usually the teeth impacted in the mandibular dentition if a lack of space exists during the sequence of eruption.(28) Although there are numerous theories of tooth eruption, the author feels that the most viable one is the formation of the root and how this causes the tooth to move toward the oral cavity. A tooth should be "ready to erupt" when 2/3 to 3/4 of its root has formed. Once the root has fully developed, then it is said that it has lost its "erupting potential." The next case to be illustrated is a perfect example of a clinician utilizing this theory of tooth eruption, and preventing tooth impaction.

Figure 128 reveals a panorex radiograph of a patient whose mandibular canine/premolar eruption pattern had been disrupted, especially on the right side of the dental arch due to the distal movement of the lower incisors. Note the development of the canine roots, and the fact that the lower right canine is below the eruption pattern of the premolars on that side of the dental arch. If no treatment had been instituted at this time, this canine would certainly have become impacted. It should also be noted that the patient had a congenitally missing lower incisor, which was the likely cause of the mandibular incisor "drifting." Figure 129 illustrates the type of mandibular removable orthodontic appliance that was used for the majority of the tooth movement procedures. It consisted of various helical loop finger springs to move the incisors toward the midline creating space for the mandibular canines to erupt. Note the double helical coil on the right side of the appliance. It was constructed in this manner to increase the amount of wire in the finger spring to allow for a more continuous force on the lower right incisors. Figures 130 through 132 show the appliance in place and activated, as well as the tooth movement that occurred following the activation of the helical loop finger springs. Figure 133 illustrates a panorex radiograph revealing the space that was opened by the treatment and the eruption pattern of the lower right canine. Figures 134 and 135 show the normal positioning of the lower canines and premolars after removable orthodontic appliance therapy. Treatment was continued, in this case with a lower 0.016" X 0.016" "utility arch wire" to intrude the incisors and correct the anterior deep overbite (incisor vertical overlap). The author feels that the general dentist should be capable of performing the treatment utilizing the removable orthodontic appliance, and that the "2nd half" of the treatment could very well be referred to an orthodontic specialist, noting the complexity of the case. This is a good example of inter-disciplinary "team work," and how the general dentist is the “watch dog” of the profession, as he or she is usually the first one to see an orthodontic problem and should be the first clinician to diagnose the patient’s situation.

Figure 127. “Bulging” of left lateral incisor prior to attaching auxiliary spring to guide its eruption.

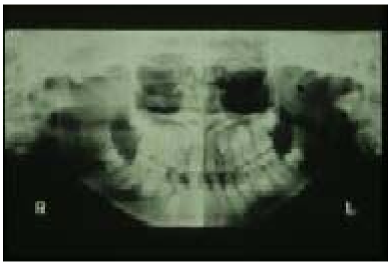


Figure 128. Panorex radiograph showing lower eruption pattern and drifting of lower incisors.

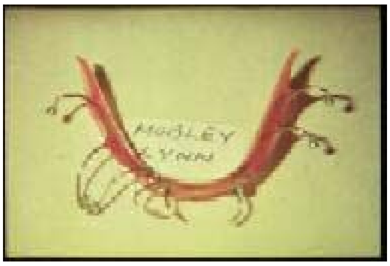


Figure 129. Mandibular removable appliance with helical loop springs to upright incisors.

Figure 130. Helical loop spring after activation.

Figure 131. Mandibular incisor beginning to upright.

Figure 132. Space opened for the eruption of lower right canine and first premolar.

Certain limited fixed appliances can also be used for anterior space closure. Figures 136 through 138 illustrate a case that was treated by a combination of fixed and removable appliances as well as with elastic therapy. Figures 139 through 141 reveal a fixed orthodontic appliance utilizing a sectional arch wire with elastic therapy to correct the midline diastema. The severity of the malocclusion, and the knowledge and skills of a general dentist should dictate the degree to which he or she becomes involved in the orthodontic treatment of complex problems. When in doubt, the clinician should seek advice, or refer the therapy of a severe malocclusion to an orthodontic specialist.

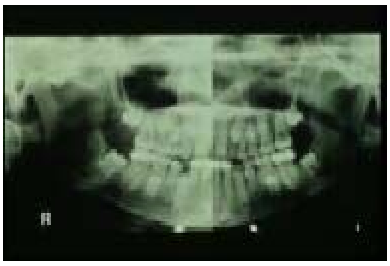


Figure 133. Panorex radiograph showing opened space and eruption pattern of lower canines and premolars.

Figure 134. Lower right canines and premolars erupted after treatment with removable appliance.

Figure 135. Lower left canines and premolars erupted. Deep overbite being treated with utility arch.

Figure 136. Occlusal view of maxillary model showing anterior diastema.

Figure 137. Closing midline diastema using a combination of a limited banded technique and a labial elastic attached to an acrylic and wire appliance.

Figure 138. Occlusion after treatment.

Frenum Attachments

A continuous and controversial question in dentistry is what to do when a labial frenum is associated with a midline diastema.(29) Often, it is obvious that the frenum is present only because there is excess space and insufficient pressure of tooth eruption to cause resorption of the fibrous connection. There may be occasions, however, where the frenum attachment is so low and the tissue so fibrous that it may very well be the cause for the midline diastema. (Figure 142)

There is a rule in orthodontics that before a "frenectomy," or the surgical removal of the frenum is attempted, every effort should be made to close the diastema orthodontically by the clinical methods previously described. There is usually an initial accumulation of the frenum tissue after space closure, followed by natural resorption. If the resorption does not take place after a certain length of time (usually three weeks) the frenectomy is then performed while retaining the orthodontic result. It is feared that if the frenectomy is performed prior to space closure, the scar tissue that forms as a result of the surgery will be more resistant than the original frenum. This will result in extreme difficulty during space-closing procedures.

Figure 143 illustrates the profile view of protruding maxillary incisors, and figure 144 shows the frontal view of the occlusion. Note the midline diastema, the low frenum attachment, and the removable orthodontic appliance that was used to correct the malocclusion. The appliance consisted of an "active" labial Hawley wire to retract the incisors, and soldered hooks on the wire for potential use of elastic therapy. A view from the palatal side reveals mattress finger springs touching the mesial-palatal surfaces of the central incisors. (Figure 145) The combined activation of the labial Hawley wire, against the distal-labial surfaces of the central incisors, and the mattress springs on the mesial- palatal surfaces of these teeth correct their abnormal rotations, along with the anterior protrusion. Figure 146 illustrates the "angry" looking frenum as its fibers accumulated after the tooth movement procedures. Figure 147 shows the frontal view of the post-orthodontic frenum attachment. After sufficient time was given for the frenum to resorb naturally, it was surgically removed during the retention phase of orthodontic therapy. (Figure 148) Figure 149 illustrates the case after orthodontic treatment and the frenectomy procedure.

Various techniques can be utilized to perform a frenectomy on an abnormal labial frenum attachment following space closure of an anterior diastema. The latest method is the utilization of an electrosurgical technique. (Figure 150) This procedure is relatively efficient and causes the least amount of bleeding, since it cauterizes the capillaries during the surgical removal of the tissue. This technique also seems to cause less scar tissue than the traditional surgical approach using scalpels.

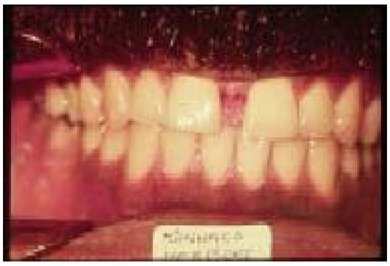


Figure 139. Midline diastema. Note parallelism of central incisor teeth.

Figure 140. Plastic edgewise brackets are bonded on incisors with 0.016" round sectional arch wire. A 3/4 inch elastic was stretched across appliance to produce necessary force.

Figure 141. Occlusion after about four months of treatment.

Figure 142. Excessive diastema associated with an abnormal frenum attachment.

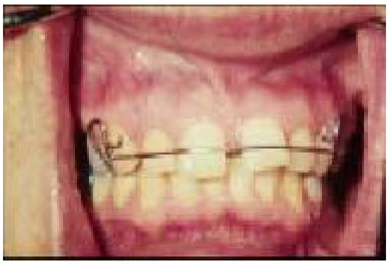


Figure 143. Protruding maxillary incisors.

Figure 144. Hawley appliance used to treat protruding incisors and to close diastema.

Figure 145. Palatal view of appliance showing mattress springs used to rotate central incisors.

Figure 146. Palatal view of hypertrophied frenum attachment after anterior space closure.

Figure 147. Hypertrophy of labial frenum following closure of midline diastema.

Figure 148. Frenectomy following space closure.

Figure 149. Occlusion after orthodontic treatment and frenectomy procedure.

Figure 150. Postsurgical view of frenectomy using electro-surgical procedure. Note all fibers of the frenum were removed, including those embedded in the upper lip.

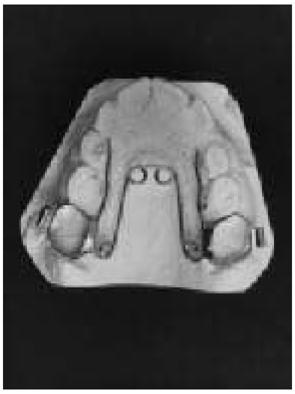


Figure 151. "Pseudo" Class III malocclusion caused by anterior displacement of the mandible.

Figure 152. Palatal view of appliance to tip incisors forward.

Figure 153. Maxillary central incisors in correct position after orthodontic treatment.

Figure 154. The mandible has returned to its correct position after advancing the upper central incisors.

Figure 155. Maxillary left canine in palatal-version, causing an individual anterior cross bite.

Figure 156. Acrylic guide plane cemented to mandibular arch.

Anterior Cross Bites

Anterior Mandibular Displacements

The midface complex and the maxilla grow downward and forward at an earlier age in a child than does the lower face or mandible.[20] Therefore, it is not uncommon to observe a convex or "Class II" appearance in the face of a growing child before the mandible "catches up." An anterior displacement of the mandible, due to local factors creating an anterior cross bite or a "pseudo" Class III malocclusion, may develop into a "true" skeletal Class III when the mandible begins to grow and develop normally.

An example of an anterior displacement of the mandible is shown in Figure 151. This anterior cross bite, due to the lingual inclinations of the permanent maxillary central incisors in the mixed dentition, may very well "lock" the maxilla and prevent its normal downward and forward growth. It is obvious that this problem should be treated early to also prevent any future temporomandibular joint dysfunction. Figure 152 illustrates the palatal view of the appliance used in the treatment of this case, showing a double helical loop spring palatal to the central incisors to produce labial movement of these teeth when activated. The posterior bite splint "dis-occludes" the anterior teeth and allows the upper incisors to move out of cross bite after the finger spring is activated. It is important to remember that the posterior bite splint acts in a manner opposite to an anterior biteplate. In other words, because the incisors are out of occlusion, they will have a tendency to "supra-erupt," thereby deepening the anterior overbite.

Figures 153 and 154 show the case after approximately eight weeks of treatment. Note also the space regained for the maxillary right permanent canine. Retention of simple cross bite treatment, whether anterior or posterior, is usually not a problem, since the occlusion helps to maintain the corrected relationship. Even though this patient may require further orthodontic treatment in the future, it is evident that a more severe problem was prevented.

Individual Anterior Cross Bites

Occasionally, due to ectopic eruption, a misplaced tooth bud, an arch length discrepancy, or some other factor causing an individual malposition, an anterior tooth may be found in "palatal-version" and therefore in an anterior cross bite. (Figure 155)

These problems are often amenable to removable orthodontic appliance therapy, acrylic guide-plane treatment, limited fixed appliance mechanics, or a combination of these methods. One of the "older," but very effective techniques used to treat individual anterior cross bites is the utilization of an acrylic guide-plane. After fabrication of the acrylic guide-plane, it is temporarily cemented to the lower dental arch, opposite to the malposed tooth. (Figure 156) The patient must be cooperative, and warned that it may cause some degree of trauma during mastication. Fortunately, the treatment time is relatively short with this appliance, and no damage is caused to the teeth during orthodontic therapy. To facilitate the treatment in this case, a fixed segmental arch wire with vertical loops was used to help in the labial movement of the maxillary left canine. (Figure 157)

Individual anterior cross bites can also be treated by the use of removable orthodontic appliances. Figures 158 through 160 illustrate a case utilizing a removable appliance with one mattress spring to advance the maxillary right central incisor. As mentioned previously, retention is seldom a problem after the treatment of individual cross bites, since the forces of occlusion aid in maintaining the tooth in its corrected position.

Figure 157. Sectional arch wire with vertical loops attached to lateral incisor, canine and first premolar teeth. Segment of the wire attached to the canine is activated in a labial direction prior to ligation to the brackets.

Figure 158. Anterior cross bite in right central incisor region.

Figure 159. Acrylic and wire appliance with mattress spring to move right central incisor into a labial position.

Figure 160. After six weeks of treatment, anterior cross bite is corrected.

Posterior Cross Bites

The reason for a majority of posterior cross bites is usually skeletal rather than dental in origin. Often the maxilla is narrow when compared to the mandible, causing a discrepancy between the two jaws. The diagnosis of such skeletal dysplasias is best accomplished utilizing a frontal cephalometric radiographic analysis to determine the width discrepancies of the jaw structures.

The clinician must keep in mind that the maxilla actually consists of two separate bony structures, both growing in a transverse direction during the active growth of a child.[20] Because of its intimate relationship to the cranial base, it is thought that the growth in maxillary width follows the neural growth curve, which is complete quite early in life, perhaps as early as 7 years of age.[30] This does not mean, however, that the mid-palatine suture of the maxilla is fused at this early age. This suture does not fuse until the 20th year of life, but it is incumbent upon the clinician to use palatal widening procedures while the patient is actively growing, and prior to the fusion of the two halves of the maxilla. In so doing, the patient's treatment is relatively uncomplicated, and the result is more stable.

Examples of skeletal cross bites can be seen in the deciduous, mixed, and permanent dentitions. The etiology of a narrow maxillary complex can be associated with a prolonged thumb sucking habit.[20]

Quad Helix Appliance

As it was explained in a previous chapter, the "quad helix" appliance has been shown to produce orthopedic effects on the maxilla in the mixed dentition and during active craniofacial growth.[23] (Figure 161) In the adult patient, the midpalatine suture is "closed" and does not allow the forces produced by the quad helix appliance to separate the two halves of the maxillary bones. Therefore, in the adult dentition, the magnitude of force created by the activation of the quad helix appliance is in the tooth movement range and acts to expand the dental units in a collapsed arch. It can be said that the quad helix appliance is "age dependent," creating orthopedic results on growing children, and tooth movement on adult patients.

The initial activation of the quad helix appliance is placed prior to cementation. An initial expansion of 8 mm will produce approximately 14 ounces of force. This magnitude is sufficient to produce tooth movement, but generally is not enough to create an orthopedic effect on adults when the midpalatine suture is closed. However, in children in the deciduous or early mixed dentition stages of development, the resistance at the patent suture is often less than in the dentoalveolar area. Therefore, this appliance is capable of orthopedically widening the maxilla in children and thereby creating a normal maxillo-mandibular relationship.

Once the appliance is cemented on the teeth, it is possible to make intra-oral adjustments to vary the forces on the dental segments. Such activations can be easily performed with a three-pronged pliers. The first adjustment is made at the anterior bridge, (Figure 162) and the second and third bends are made at the posterior one-third of the palatal bridges. (Figure 163)

Rapid Palatal Expansion

There has been an evolution of removable and fixed appliances to expand collapsed dental arches or narrow maxillae. One of the first appliances designed for the "rapid" expansion of the palate was by Haas(31) after his experimentation on the maxillae of pigs. Interestingly enough, Haas found that more than any other experimental animal, the pig's maxillary suture resembles the human's structure. Since it is difficult to produce maxillary orthopedic effects after active growth has ceased, it has been found that rapid palatal expansion can be accomplished using the Haas appliance. Since these orthopedic appliances affect numerous sutures of the craniofacial complex, extreme care must

be taken when using such devices. It is also extremely important for the clinician to perform a thorough pretreatment evaluation, especially using a frontal cephalometric analysis.[32] (Figure 164)

Figures 165 and 166 represent a skeletal cross bite in a 16 year old female patient. Although this patient may seem relatively young to most clinicians, she can be considered an adult in terms of the growth of her craniofacial complex, keeping in mind that the majority of growth of female patients is complete by the age of 13 years.[20] Figure 167 illustrates a palatal view of the appliance used to expand this case. The typical rapid maxillary expansion appliance is cemented to the maxillary first premolars and first permanent molars, augmented by a palatal jack-screw and acrylic extensions. The rapid maxillary expansion appliance is activated by slowly turning the threads of the jack-screw a full revolution at the time of cementation. The patient is then instructed to activate the appliance two one-quarter turns per day for about one week. The patient should be seen frequently during this important phase of treatment. Figure 168 reveals the amount of palatal expansion that had occurred after approximately one week of activation of the appliance. Figure 169 shows the palatal radiograph of the patient, revealing the mid-palatal suture opening. The opening in the suture is initially filled with connective tissue, after which time bony apposition occurs. Figure 170 illustrates the same radiographic view several months after palate separation. Note that the mid-palatal suture has filled with bone, and that the inter-dental fibers between the maxillary central incisors have brought the teeth together, closing the diastema that was created by the rapid palatal expansion. After sufficient expansion has been accomplished, the jack-screw is covered with acrylic and the appliance is kept in place for at least 90 days for proper retention and healing of the various sutures. (Figure 171)

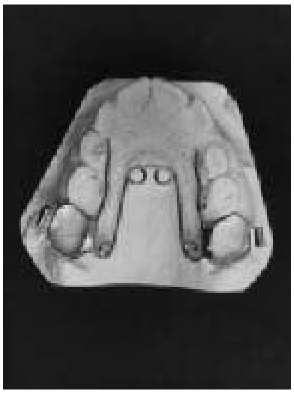


Figure 161. Quad helix appliance constructed on the model of a patient with mixed dentition and a narrow maxilla.

Figure 162. First intra-oral adjustment is made at the anterior bridge with a three-pronged pliers as shown here.

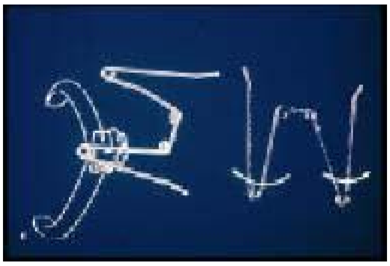


Figure 163. Activation of the appliance with this adjustment expands and rotates the molars in the direction of the arrows.

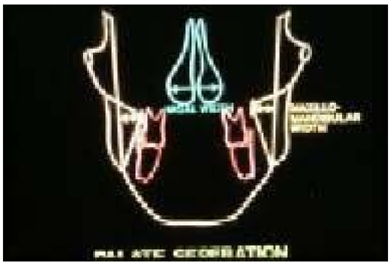


Figure 164. Diagram of a frontal cephalometric radiograph to determine the need for palatal expansion.

Figure 165. A skeletal anterior and posterior cross bite in the adult dentition necessitating rapid palatal expansion.

Figure 166. Note Class III relationship and severe anterior cross bite.

Clinicians who have never utilized rapid maxillary expansion appliances often ask what the patient's symptoms or feelings are during the activation of the appliance. The author has found that the symptoms are relatively mild, other than a pressure sensation at the bridge of the nose during the initial activation. This is more than likely due to the effect of the suture between the maxilla and nasal bone. The clinician must keep in mind that these orthopedic appliances are actually medical devices. Used cautiously, they can produce meaningful results, but if abused, they could cause great harm to the patient. According to Gray[33], the maxillae articulate with nine bones, two cranial and seven facial. The activation of the rapid maxillary expansion appliances affects every one of these bones![34]

Individual Posterior Cross Bites

Occasionally, one or more posterior teeth may be in unilateral cross bite. This cross bite usually arises from insufficient space for a tooth or several teeth to erupt properly into the dental arches. Most importantly, care must be taken that the cross bite is truly unilateral and not caused by a lateral displacement of the mandible. If the cross bite is reciprocal, due to displacement of the upper and the lower teeth, then inter-maxillary cross bite elastics can be used to treat both malpositioned teeth. (Figure 172) In most cases, a 1/4 inch - 3 1/2 ounce elastic is the one of choice for such treatment. The patient changes the elastic at least every other day in order to avoid using elastics that have fatigued, thus losing their potential to move the teeth effectively.[26]

Although the bucco-lingual vector of force is the one that the clinician is most concerned with in the treatment of posterior crossbites, it is the vertical pull that may cause damage to the teeth and the occlusion.[35] Not only can an excessive amount of force devitalize a healthy tooth, but it will also extrude the teeth, especially if the patient wears the elastics during mastication. This is especially important if the patient has an anterior open bite, since extrusion of posterior teeth will increase the severity of the malocclusion.

Figure 167. Palatal view of a rapid maxillary expansion appliance prior to activation.

Figure 168. Palatal view of patient after one week of treatment with the rapid maxillary expansion appliance.

Figure 169. Palatal radiograph of rapid palatal expansion after one week of treatment.

Figure 170. Palatal radiograph of rapid palatal expansion three months after the start of treatment.

Figure 171. Palatal jack-screw is covered with acrylic after treatment to retain the expansion for at least 90 days.

Figure 172. Intermaxillary elastic on palatal surface of upper tooth and buccal surface of lower tooth to reciprocally treat an individual

cross bite.

Orthopedic Force Application

There are two types of forces used in orthodontics: orthodontic or tooth-moving forces, and orthopedic forces that affect the deeper craniofacial structures.[21] Orthodontic forces are those that are applied to the teeth by the wires of removable and fixed appliances. The force produced by the adjustments to these wires ranges from 50 to 500 grams, whereas orthopedic forces are much greater.

Head Gear cervical high pull combination	(The head gear utilizes the upper molar tooth as a “handle” and transmits the forces to various sutures to treat Class II problems. Depending on the needs of the case, different vectors of force are used.)
Chin Cup Class III high pull	(The chin cup is used to transmit the forces to the developing mandible to treat Class IIIs or open bites.)

Head Gear

The head gear consists of an inner bow (Figure 173) that attaches to maxillary molars, and the outer bow which is connected to the inner bow. (Figure 174) Attached to the outerbow is an elastic mechanism around the patient’s head or neck. (Figure 175) The inner bow is made from 0.040" stainless steel round wire, and fits into the head gear tubes of the upper first permanent molar bands. In order to stop the inner bow in front of the molar tube, either a vertical loop or a “bayonet” bend is placed, as shown in Figure 173.

The outer bow is made of a stainless steel round wire of 0.050" in diameter. It is soldered in front to the inner bow with its ends bent in the shape of hooks for the connection of the rubber band or the elastic strap portion of the gear.

The most widely used orthopedic appliance to direct forces on the maxillary complex is the cervical gear or the Kloehn head gear, named after the person who invented it.(36) This is the type of device illustrated in Figure 175. The outer bow is connected to an elastic strap which is anchored around and behind the patient’s neck. Since the cervical position is lower than the maxillary molar teeth, this appliance has the tendency to produce an extrusive force on the attached teeth. This occurs, even though a patient is usually instructed to wear the appliance for a period of 12-14 hours per day, including the hours during sleep. Therefore, the cervical gear is contraindicated in an open bite type of malocclusion, since molar extrusion would complicate this type of problem.

In order to avoid this complication, a “high pull” head gear is used, which produces a more superiorly directed vector of force. (Figure 176) This type of an appliance prevents the extrusion of the upper molars, but its efficacy in causing distal movement is relatively slight. A combination head gear can be used which takes advantage of the distal pull of the cervical gear and the high pull of the head gear. (Figure 177)

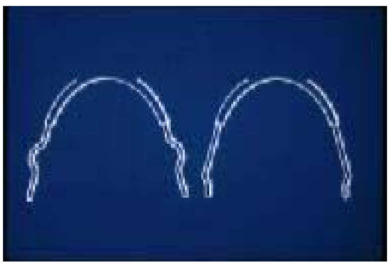


Figure 173. Inner bow of head gear, with vertical loops (left) and bayonet bends (right) to stop the inner bow in front of the molar tubes.

Figure 174. Inner bow connected to the outer bow to complete the head gear assembly. Hooks of the outer bow are for attachment of elastics.

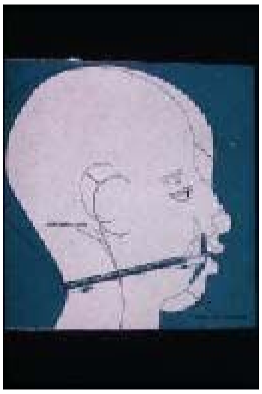


Figure 175. Diagram of Kloehn neck gear. Vectors of force are directed below the plane of occlusion causing extrusion of upper posterior teeth.

Figure 176. High pull head gear. Superiorly directed vectors of force prevent extrusion of posterior teeth.

Figure 177. Diagram of combination head gear with high pull and cervical vectors of force.

Figure 178. Dr. Angle's original combination head gear.

Figure 179. Chin cup appliance to redirect the growth of the mandible and treat a skeletal Class III malocclusion.

Figure 180. Diagram of chin cup appliance for treatment of skeletal Class III (left) and skeletal open bite (right).

Figure 181. Dr. Angle's original "head cap" appliance.

Although they were "re-popularized" by Kloehn in the 1950's, orthopedic appliances are certainly not what one would call new. In the late 1800's, Angle, the "father" of modern orthodontics wrote about orthopedic forces and how they could effect the maxilla and mandible.[37] Figure 178 reveals Angle's first head gear, in this case a combination gear utilizing both cervical and high pull vectors of force.

Chin Cup

Just as head gears apply orthopedic forces to the upper jaw to redirect the growth of the maxilla in Class II skeletal malocclusions, the chin cup appliance places orthopedic forces on the mandible to redirect the growth of the lower jaw during the treatment of Class III skeletal malocclusions. (Figure 179) Figure 180 illustrates the chin cup for treatment of Class III malocclusions on the left, and on the right, a high pull chin cup showing the vertical vector of force during the treatment of skeletal open bite malocclusions.

Long before their current use, Angle explained the utilization of chin cups to produce orthopedic forces on the mandible in the treatment of skeletal Class III malocclusions.[37] He termed this device a "head cap." (Figure 181)

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