“AGE-APPROPRIATE” PEDIATRIC ORTHODONTICS:

Dentofacial Diagnostic & Orthodontic Treatment Considerations & Strategies In Growing Patients

Interceptive, multi-phased and staged orthodontic treatment options and strategies for dealing with:

- Crowding in the Early Mixed Dentition – Age 6 to 9 years
- Crowding in the Late Mixed Dentition – Age 10 to 12 years
- Posterior Crossbites (Functional & Bilateral) in the Primary, Mixed and Adolescent Dentitions
- Anterior Crossbites – Dentoalveolar, Functional (Pseudo-Cl. III) & Skeletal Class III Malocclusions in the Primary & Mixed Dentitions
- Pronounced Overjet – Deleterious Habits and/or Class II Malocclusion in the Mixed and Adolescent Dentitions
- Ectopic Eruption Patterns in the Mixed Dentition – Permanent First Molars, Permanent Lower Incisors, Permanent Maxillary Canines
- Congentially Missing Permanent Teeth – Maxillary Lateral Incisors, Upper & Lower Second Premolars

Ronald A. Bell, D.D.S., M.Ed.
Diplomate, American Board of Pediatric Dentistry
Diplomate, American Board of Orthodontics
Department of Pediatric Dentistry/Orthodontics
Medical University of South Carolina
Charleston, South Carolina
bellr@musc.edu

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“Age-Appropriate” Orthodontic Diagnosis & Treatment

Ronald A. Bell, D.D.S., M.Ed.  bellr@musc.edu
Professor of Pediatric Dentistry & Orthodontics, Medical University of South Carolina
Diplomate, American Board of Pediatric Dentistry & American Board of Orthodontics

Comprehensive orthodontic treatment implies that, whenever possible; management of the occlusion results in Class I orthognathic facial balance with the dentition positioned over basal bone and within a harmonious neuromuscular environment. This objective provides the rationale for diagnosis in growing patients and strategically timed treatments appropriate to developmental stages that lead the clinician and the patient towards achievement of the overall objective. "Age-appropriate” orthodontic treatment may be defined as:

“Treatment started in the primary, mixed, or young permanent dentitions that is performed to enhance dental, facial, skeletal, and functional harmony before growth is complete with the purpose of intercepting or facilitating correction of a developing malocclusion, reducing the need, complexity, or time of full Edgewise treatment in the permanent dentition, and optimizing comprehensive treatment outcomes.”

“Age-appropriate” intervention encompasses orthodontic treatments associated with:

1.) **interceptive and guidance of eruption** procedures in the primary and mixed dentition stages,

2.) **multi-phased treatments** involving an initial active stage with targeted objectives in the early to mid-mixed dentition, an observation stage, and a later stage of treatment into the permanent dentition,

3.) **staged treatments** started in the late mixed dentition to influence growth and arch development that lead into the full permanent dentition, and

4.) **comprehensive Edgewise orthodontics** in the permanent dentition to optimize dentofacial outcomes.

**Goals in Management of the Developing Dentition** - Directed toward achieving targeted dentitional alignment and interarch occlusal relationships, “age-appropriate” interventions ranging from interceptive to phased to staged orthodontic treatments are designed to attain:

1.) Solid Class I molar positioning with proper rotational alignment;
2.) “Normal” anterior overbite, overjet and alignment;
3.) Coordinated upper to lower arch widths without functional deviations;
4.) Space available to accommodate canines and premolars;
5.) Symmetrical dental arches positioned over basal bone;
6.) Esthetically and functionally balanced dentofacial relationships.

Based on the definition and conceptual goals, one can conclude that almost any malocclusion factor associated with growth and development in the primary and mixed dentitions presents both common sense and evidenced-based considerations for “treating it now” or at the very least having a plan and rationale for delay. These types of problems include the recognition and planned management of:

- Space maintenance with early loss of primary molars or space regaining if space loss has occurred.
- Transverse problems - maxillary expansion needs (eg. posterior crossbites, Class II, Div 1 patients)
- Excessively protrusive maxillary incisors > +6 mm. or more overjet, no protection from lip coverage.
- Deleterious oral habits - Digi sucking, lip-mentalisis-tongue thrust, and compromised airway patterns.
- Esthetic concerns - severely displaced incisors, classically Class II, Div. 2 or “splayed” incisors.
- Preservation of Leeway space – resolve crowding with guidance of eruption and arch development.
- Initiate serial extraction protocols with severe tooth size-arch size discrepancy.
- Ectopic eruption and impacting teeth (permanent upper 1st molars, lower laterals, upper canines).
- Effects of and options to deal with supernumerary or missing teeth.
- Skeletal discrepancies - Sagittal (Class II, III) and Vertical (skeletal openbite, skeletal deepbite).
Advantages / Rationale for “Early” Diagnosis and Orthodontic Treatment

In line with comprehensive objectives, the advantages of early diagnosis and “age-appropriate” treatment compared to later in the traditional adolescent permanent dentition timing includes the following factors:

1.) **Space Supervision & Guidance of Eruption** - Studies demonstrate the most common malocclusion problem is a tooth size-arch length discrepancy as manifest by crowding and malalignment in the lower incisor segment. The normative amount of lower incisor crowding in the mid-mixed dentition approximates an incisor liability of about 2 mm. with a standard deviation of ± 1mm. This indicates that lower incisor crowding of 1 to 4 mm. is expressed in the vast majority of children at 8 to 9 years of age after incisor eruption.

**Normal Dimensional Factors**

- 1 to 2 mm. of lower incisor crowding is normative finding after lower incisor eruption is complete with a S.D. of ± 1 mm.
- Up to 3 to 4 mm. of lower crowding represents two standard deviations to the negative side.

Studies of normative development and malocclusion findings indicate that anterior malalignment becomes more prevalent and exhibits greater severity between the mixed dentition after initial incisor eruption and the transition into the adolescent young permanent dentition. These findings suggest that normative transitional arch dimensional changes do not compensate for anterior malalignment present in the mid-mixed dentition. Detailed assessment of these studies shows that normative arch width changes do not occur after lower incisor eruption as the intercanine width is established upon eruption of the lower incisors by age eight years.

The studies assessing dimensional changes occurring in the transitional dentition show arch length tends to shorten about 2 to 3 mm. per quadrant as the buccal segment dentition exfoliates and late mesial shift of the first molars accommodates to occlusion changes. The lack of width increase in the lower anterior segment after lower incisors have erupted and the decrease in arch length concurrent with buccal transition, along with some incisor up-righting that typically occurs as overbite and overjet are established; results in a notable overall decrease in arch perimeter as the mixed dentition transitions into the young permanent occlusion. This arch perimeter decrease of up to 4mm. in the lower arch explains why mixed dentition crowding either stays the same or more typically worsens in the period from the mixed into the young permanent dentition.

**Normative Dimensional Changes**

With loss of second primary molars around age 11 to 12 years, first permanent molars shift forward at the expense of Leeway or “E - space”.

**Dimensional Factors**

Result is an average AL decrease of 2 to 3 mm. in each of the bilateral lower quadrants.

**Arch Perimeter Changes (mm.)**

- **< Inc >** Incisor Transition period
- **< LMS >** Late Mesial Shift period

Bilateral decrease in A.L. & lack of anterior width increase results in **average reduction in lower arch perimeter of 4 to 5 mm. during late transition.** This normative finding further compromises expression of lower crowding.
Since arch circumference decreases anterior to the first permanent molars during normal development and with “space loss” often complicating alignment when arch integrity has been disrupted in the primary and mixed dentitions, it is often desirable to supervise the eruption sequence and positioning of the permanent teeth during the transitional occlusion. The control of leeway space in terms of arch dimensional change through space supervision and guidance of eruption techniques may offer opportunities to significantly improve tooth size-arch size adjustments for the relief of typical levels of dental arch crowding. It is important to point out that the leeway space of +1.7 mm. per mandibular quadrant is most directly related to the size difference between the second primary molars and their successor second premolars. This “E-space” approximates a plus 2 to 3 mm. in comparative widths and represents the last teeth to normally transition in the lower buccal segments.

Leeway Space & E-Space Values

While normative transverse & A-P changes offer no relief to lower anterior crowding after incisors are erupted, Leeway space is potentially available for crowding relief prior to exfoliation of buccal segment primary teeth & before the late mesial shift of the permanent molars occurs.

Mandibular = +1.7 mm.

Leeway space more accurately referred to as the “E-space” since overall size difference actually represents greater width of 2nd primary molars compared to succeeding 2nd bicuspids.

Lower “E-space” about 2 to 3 mm. per side.

Last lower primary tooth to normally exfoliate.

Space supervision and guidance of eruption procedures in the mixed dentition are considered applicable in children with adequate or mildly deficient arch dimensions (i.e. less than 5 mm. per maxillary and 3 mm. per mandibular arch) with the size deficiency incorporating any available bilateral leeway space. Clinical studies indicate supervision and control of leeway / “E-space” will accommodate typical lower incisor crowding in approximately 75% of mixed dentition patients presenting for orthodontic treatment. A common procedure to supervise leeway/E-space in the lower arch is the timely use of a lower lingual holding arch placed prior to exfoliation or selective extraction of the primary molars. The lower lingual holding arch has been demonstrated to hold first molars from forward movement and the lower incisors from lingual up-righting with the sustained arch perimeter used to enhance lower incisor crowding relief on the order of 2 to 4 mm. as the canines and premolars erupt in a more distal orientation.

Lingual Holding Arches & Guidance of Eruption

Long-term follow-up of timed lingual holding arch placement and lower arch dimensional changes ➔

1. Arch length / perimeter decreased minimally ➔
   > reduced forward movement of molars.
   > reduced incisor lingual up-righting.

2. Buccal arch length maintained.


4. Lower incisor crowding relieved on a consistent basis at a 2 to 4 mm. level.

In keeping with the idea of supervising space changes in the transitional dentition, patients must be diagnosed and evaluated for space supervision before the transition of the buccal teeth in each arch. A good clinical guide for timing is upon the clinical emergence of the lower canines, lower first premolars and upper first premolars.
These teeth erupt about one to one and one-half years ahead of the final buccal segment transition, leaving adequate time to assess overall dimensional needs and plan treatment interventions for the relief of crowding.

The dimensional parameters of leeway space in the transitional dentition provides the developmental potential for a non-extraction approach in orthodontic management with enhanced esthetics and functioning occlusion as achievable goals. The reasons for a conceptual non-extraction approach are varied - enhanced facial profile with intact natural archform, healthier more physiologically balanced occlusion and TMJ apparatus, avoidance of removing sound teeth, retention-stability concerns, periodontal considerations, etc. Such a list implies orthodontic extraction of permanent teeth leads toward a negative result as a general rule. This is not the case as a significant proportion of patients present malocclusion factors and dentofacial patterns in which an extraction protocol is consistent with overall objectives. As a conceptual model however; a non-extraction approach for the majority of patients possessing developmental potential for a full complement of teeth provides a sound foundation for orthodontic diagnosis and treatment.

2.) Growth Modification - A second advantage of diagnostic timing in the mid- to late mixed dentition (nine to twelve years of age) is that it generally precedes the pubertal growth spurt in females, which is in turn approximately two years ahead of the pubertal growth spurt in males. If a skeletal malocclusion is noted, the opportunity for growth modification presents itself as a feasible treatment option in the pre-pubertal and pubertal growth periods so as to influence in a positive manner skeletal discrepancies through the utilization of dentofacial orthopedic procedures to hopefully achieve orthognathic Class I relationships.

Approximating late mixed dentition buccal segment transition time at 10 to 12 years of age, most girls are just before the start or just beginning their pubertal growth spurt. Stage G of lower canine root development where the apical areas are parallel occurs within one year of the peak for girls as a reference. Boys typically start their growth spurt about two years later at the end of the transition or into the adolescent dentition. In either case, the peak of the spurt curve lasts about 18 to 24 months. This is an excellent time to address Class II skeletal problems with growth modification procedures since both the maxilla (dashed lines) and the mandible (solid lines) express some degree of differential growth rate in timing with the pubertal growth spurt.
3) **Simpler Biomechanical Applications** - The dynamics of growth and development allow enhanced dental and skeletal responses with the application of less complex biomechanical force systems. More effective, efficient, and controlled treatment results are attainable with directed orthodontic and orthopedic forces applied in transitional dentition stages. Space gaining and arch expansion procedures are more readily achieved and generally considered more stable during the transitional dentition. Additionally, phased segmental mechanics in association with growth guidance enhances oral health parameters of the dentition and periodontium. This applies to vertical control of incisor and buccal eruption patterns for adjustments in excessive overbite, openbite, and leveling of the curve of Spee as well as incisor malalignment with periodontal tissue implications.

4) **improved Psychological Well-being** - Psychological aspects of treatment in terms of patient motivation, improved and more dramatic dentofacial changes, a social desire for treatment, and cooperative age results in improved psychological well-being of the child and parents as well as a practice-builder.

5) **Potential for Optimal Results** - The greater number of treatment options available in growing patients offers the potential for optimal treatment results without having to resort to compromised treatment options often necessary in non-growing patients. Late mixed dentition timing offers a wider “window of opportunity” to take advantage of peak growth velocities to influence skeletal growth in a “positive” manner for facial balance. The variety of treatment options along with the ability to modify and redirect growth patterns enhances our ability to achieve dentofacial esthetics, comfortable functional occlusion, and treatment stability. In sum, the potential benefits of “early” orthodontic treatment related to optimal results include an understanding that:

- It is possible to obtain successful orthopedic corrections in growing patients that reduce the need for surgical orthodontics. Note that females should be treated earlier than males for growth modification.
- Coordination of transverse widths of the arches with an emphasis towards orthopedic expansion of the maxillary palatal shelves over lateral dental expansion is enhanced.
- Eliminating or reducing the impact of harmful habits enhances dentofacial balance.
- Managing space to minimize future permanent tooth extractions or “over-expansion” is feasible.
- There is a potential for a decreased extent of definitive treatment with a shortened or simplified second phase, possibly even elimination of the need for a second phase.
- Guiding teeth into favorable positions produces more stable results than mechanical movements.
- There is a reduced incidence of root resorption, mucogingival problems, and ectopic eruption problems with guidance interventions over biomechanical movements.
- There is better patient compliance in the school-age child than in adolescents.
- Improvement in patient self-esteem is of positive benefit to children.

While emphasizing the potential advantages, one must recognize there are significant disadvantages to “early” treatment that must be considered when weighing the need for intervention. These include:

- Prolonged treatment time – things happen slowly; but timing of interventions is critical.
- Multiple problems often arise, but not always at the same time.
- Untoward responses often happen given the variability of growth dynamics.
- Patient immaturity – Child cannot cope with discomfort, behavior interferes with treatment.
- Patient and/or parent burnout due to multiple treatment interventions, length of involvement, etc.
- Additional cost $$$$$$
- Potential for iatrogenic damage to teeth - Dilaceration / resorption of roots (especially maxillary lateral incisors), decalcification under and around bands/brackets left on too long, impaction of maxillary canines by premature up-righting of lateral incisor roots, and impaction of permanent second molars from holding / distalizing first molars.
- One should emphasize that some of the “claimed clinical advantages” lack scientific evidence.
STRATEGIC PRIORITIES IN PRIMARY & MIXED DENTITION ORTHODONTIC TREATMENT

Primary and mixed dentition treatment timing offers the potential for optimal results in achieving the stated goals of facial esthetics, dental esthetics, comfortable TMJ-occlusion, and treatment stability without having to resort to compromised treatment options in the non-growing patient or the full permanent dentition patient with a significant tooth size-arch size discrepancy. Keys to successful orthodontic treatment in growing patients are:

1.) Appropriate patient selection,
2.) A commitment to the effort required to ensure our desired dentofacial goals,
3.) A biomechanical strategy for addressing malocclusion problems in all three planes of space,
4.) Precise and timely usage of appropriate appliances.

The large number of treatment options and approaches available when diagnosing and planning treatment in the primary and mixed dentitions presents multiple and complex choices in both short and long-term considerations of orthodontic outcomes. Of equal importance, early diagnosis does not automatically imply early treatment - the plan is quite often to delay treatment until the optimal time for the best results. It is better to be too early than too late in diagnosis and treatment planning; but it is just as frustrating to treat too soon or too aggressively and “burn” the patient out before optimal results are achieved. In terms of patient selection, key questions to ask when considering “early” treatment involve:

- **What is the condition?**
  - What is the specific problem?
  - How did it happen?
  - Is the etiology resolved?
  - What will happen without treatment? Will it stay the same – get worse – go away?

- **What is the likely result of treatment?**
  - Will it establish a favorable growth and arch development pattern?
  - Will it eliminate future treatment?
  - Will it simplify future treatment?
  - Are biomechanical options favorable for treatment intervention?
  - Does treatment meet socioeconomic issues and patient cooperation abilities?

In answering these questions in the evaluation of growing patients, **KEY STRATEGIC PRIORITIES** in diagnosis, treatment planning, and in selecting biomechanical interventions are as follows:

- **Strategic Priority #1** > Space Supervision, Eruption Guidance, Interceptive Orthodontics
- **Strategic Priority #2** > Arch Development With Increased Arch Dimensions
- **Strategic Priority #3** > Transverse Maxillary Expansion
- **Strategic Priority #4** > Control of Functional Problems
- **Strategic Priority #5** > Control of Vertical Development
- **Strategic Priority #6** > Dentofacial Orthopedics

Each of these strategic priorities are presented in the following schematic outlines as separate entities; but their diagnostic and treatment applications often overlap in the context of orthodontic care. For example, the need for maxillary expansion to correct a transverse discrepancy (i.e. posterior crossbite) will concurrently increase maxillary arch dimensions. The rationale and significance of each strategy as a priority factor in diagnosis and treatment along with suggested protocols for their implementation given different diagnostic parameters are presented in terms of preferred biomechanical treatment options.
STRATEGIC PRIORITY #1: Space Supervision, Eruption Guidance, Interceptive Orthodontics

Rationale: Arch length and arch perimeter dimensional changes tend to decrease anterior to the first permanent molars during normal developmental patterns. Crowding is the most common malocclusion variable and the one that shows increasing incidence and severity during the transitional dentition. Space supervision encompasses procedures derived from clinical judgment where the dentist determines that a patient’s occlusion will have a better chance of obtaining optimum development with supervised intervention than without intervention (Moyers).

Significance: Due to normative developmental patterns, it is often desirable to supervise the eruption sequence and positioning of the developing occlusion during the transitional dentition to make optimal use of developmental potentials - specifically the “E - space”. Additionally, “space loss” secondary to dental caries and/or early loss of primary molars frequently complicates the transitional alignment when arch integrity is disrupted in the primary and mixed dentitions. Guidance of eruption and space supervision procedures to hold available leeway and E-space are directed toward the following treatment goals:

• Maintaining symmetrical molar positions without symptomatic space loss.
• Establishing incisors on facial midline with normal alignment integrity – no excessive protrusion, lingual malpositioning, anterior openbite, or excessive deepbite.
• Minimizing encroachment of leeway space, maintaining buccal segments arch integrity.
• Using minor tooth movement concepts to correct eruption problems in the transitional dentition.

Biomechanics: Guidance of eruption involves procedures to influence the eruption patterns and positioning of the permanent teeth during the transition from the primary dentition through the mixed dentition when the overall space is adequate to accommodate a normal complement of permanent teeth with acceptable esthetics and function (Hotz). Encompassing concepts of space supervision and interceptive orthodontics, guidance of eruption typically incorporates one or more clinical procedures to make beneficial changes in occlusion development and maintenance of arch integrity.

1. Space Maintenance - To stabilize molar and/or anterior tooth positions, space maintainers may be indicated in cases where premature tooth loss has occurred to maintain arch dimensional integrity. Space maintainers are also selectively used in the late mixed dentition to control normative arch length changes by holding first permanent molars from late mesial shift and incisors from lingual retroclination.

2. Disking or Slicing of Selected Primary Teeth - The reapproximation of mesial and/or distal tooth structure to reduce the mesiodistal diameter of a primary tooth to improve the position of adjacent permanent teeth through timely use of leeway space. This procedure is most often employed to reduce primary canine width in allowing more space for incisor alignment and on second primary molars to enhance distal drift of erupting permanent canines and first premolars.

3. Extraction of Selected Primary Teeth - When there is obvious crowding of erupting permanent teeth and disking procedures will not be adequate or appropriate to perform, the timely removal of carefully selected primary teeth may be desirable to enhance the alignment of erupting teeth.

4. Limited Tooth Movements / Interceptive Orthodontics - When tooth displacements occur and other occlusion factors are favorable (e.g., adequate arch length, stage of development, cooperation), interceptive orthodontic procedures of a limited nature involves active tooth movements to direct developing occlusions towards “normal” patterns, not necessarily “ideal” patterns of development. Implies simple appliance therapy over a short interval of treatment time. Conditions considered for minor tooth movement procedures include correction of ectopic molar eruption patterns, dentoalveolar - functional anterior crossbites, posterior crossbites, and deleterious oral habits (see following pages).

5. Recognition and Correction of Dental Anomalies - The identification and consideration of various dental anomalies as they affect the development of the occlusion are important factors in a guidance of eruption program. The correction or elimination of the effects of such variables as supernumerary teeth, missing teeth, tooth size / shape anomalies, ankylosis, pathologic lesions, etc., is important to minimize their influence on occlusal development.
ACCEPT "AS IS" >> average amount of lower anterior crowding is - 1.5 ± 1.0 mm. after incisor eruption is complete. No subsequent "growth" changes will increase lower anterior canine to canine arch dimensions. Preferred approach during incisor transition is to allow "wedging" effect of eruption. After lateral incisor eruption, what you see is what you get! Diagnose and consider the following:

DISKING OF PRIMARY CANINES >> 1 to 2 mm. of space per side can be achieved by disking mesiolingual corner to provide "sluice-way" for incisor alignment. Indicated at 7½ to 8½ years of age with:

- Less than 3 to 4 mm. of incisor crowding.
- Laterals actively erupting or aligning in arch.
- Intact primary canine roots (Not ectopically resorbed or normal timing of exfoliation).
- Incisors lingually malpositioned.
- Preferred option # 1 - especially in deep bite / brachyfacial occlusion patterns.

Disking Technique:
- Tapered bur (#699) allows access
- Must go subgingival to free contacts
- Local anesthesia may be needed for gingival slice - coordinate treatment plan.
- Careful with laterals (e.g. wedge)

EXTRACTION OF PRIMARY CANINES >> Enhance symmetry, coincident midlines, incisor integrity when:

- Incisor liability greater than 4 mm.
- Distorted incisor positioning, particularly asymmetric eruption.
- Ectopic loss of primary canine unilaterally that results in dental midline shift.
- Frequently Step One of serial extraction program, particularly vertically sensitive openbite patterns.

Recognition - Clinician must understand and relate to parent that:
- Extraction is "Robbing Peter to pay Paul".
- Extraction not a cure-all - necessity indicative of significant problems.
- Orthodontic P.R. = Consult indicated with clinician ultimately doing orthodontics.
- Negative effects = lingual collapse of incisors, arch length loss, bite deepening and increased overjet - all significant detriments in brachyfacial / deepbite cases.

PHASE I ACTIVE ARCH DEVELOPMENT >> Positioning of incisors & molars in favorable Class I relationships with incisor integrity, midline coincidence, and normal overbite & overjet. Discrepancies requiring canine extraction or extensive arch expansion to relieve incisor crowding and offset negative effects of space loss are candidates. Amount of discrepancy and facial type are critical factors in decision making process as to long term extraction versus non-extraction arch development.

- Brachyfacial / Deepbite >>> Prioritize arch development / expansion.
- Dolicho facial / Openbite >>> Extraction protocol much more likely.

Typically 2 X 4 set-up, sometimes supplemented with lip bumpers - followed by lingual holding arch for retention. Actually carries over into Strategic Priority #2 - directed expansion of arch dimensions.

STRATEGIC PRIORITY #1 ➔ “Correct” Ectopic Eruption of Six-Year Molars

DEFINITION: Resorption of second primary molars by erupting six-year molars - incidence 2% in maxillary arch, rare in lower. Self-correction reported in two-thirds of cases without significant implications. Diagnosis with Panorex or adult BWX (#2) at age 6 to 7 years; symmetry of eruption timing.

SIGNIFICANCE OF UNCORRECTED ECTOPIC MOLARS:

- Cardinal Sign of Significant Tooth Size - Arch Size Discrepancy
- Potential Space Loss in Arch Length and Circumference
- Asymmetric Arch Development - including supraeruption of opposing dentition.
- Pain and Neuralgia - extremely rare as presenting factor

TREATMENT CONCEPTS: Observation: Since approximately 2/3 self-correct, watchful waiting often legitimate approach if detected at age 5 or 6 years. Rarely self-corrects after age 7.
Interceptive Orthodontic Therapy With Eruptive Guidance Appliances: Goals
• Guide or Place First Molar Into Normal Position
• Retain Favorable Eruption Sequence - Hopefully Retain Primary Molars
• Maintain Arch Length
• Maintain Level Occlusal Plane

CONSIDERATIONS IN TREATMENT PROTOCOL:
• Arch length status: short and long-term orthodontic considerations
• Extent of blockage
• Degree and nature of primary tooth resorption
• Direction of displacement
• Timing - Do not wait once lower first molar reaches occlusal plane, Age 7 years.
• Presence or absence of bicuspids
• Patient cooperation

MECHANICAL OPTIONS: Assumes access to 1st molar for appliance engagement – occasionally requires surgical exposure.

1. Brass Ligature Wire (.020 to .026) or Elastic Separators (Preferred) - Minimal Lock
2. Removable Maxillary Hawley with Distalization Springs
3. Fixed Palatal Arch Wire From E’s With Distalization Spring To First Molar (Humphrey Appliance)
4. Fixed Palatal Archwire From E’s With Distalization Elastics To Bonded Button On First Molar (Halterman Appliance) - Preferred approach

STRATEGIC PRIORITY #1 ➔ “Correct” Dentoalveolar / Functional Anterior Crossbites

DEFINITION - Maxillary incisors lingually positioned to lower incisors in centric occlusion.

• Dental: Lingually malpositioned upper incisors behind lower incisors related to local tooth displacements - usually involves 1 or 2 teeth only. Usually over-retained primary incisors when centrals involved. If laterals in X-bite, suggests tooth size-arch size problem.

• Functional: Dentoalveolar crossbite with lingually displaced upper incisors complicated by anterior shift of the mandible to exaggerate crossbite discrepancy (pseudo-Class III). Usually incisor first contact with shift to full crossbite in maximum intercuspation.

• Skeletal: True Class III with prognathic mandible and retrognathic maxilla - usually involves multiple teeth in crossbite with total anterior and posterior constriction.

DIFFERENTIAL DIAGNOSIS: Evaluate CR - CO differences for following variables:

• Facial Profile: With functional shift becomes more prognathic, without shift profile static.
• Number of Teeth: One or two probably dental; if all incisors then more likely functional or skeletal.
• Mandibular Closure Pattern: If can self-contact incisors edge-to-edge, functional shift present.
• Molar Relationships: Class I > III with or without shift, changes on closure.
• Cephalometric Analysis: Skeletal vs. Dental, Incisor inclinations a key to diagnosis -
  • retroclined uppers, proclined lowers = dental / functional
  • proclined uppers, retroclined lowers = skeletal
• Familial Appearance

TREATMENT PLANNING - DENTAL & FUNCTIONAL ANTERIOR CROSSBITE: Almost always involves labial movement of maxillary incisors to normal anterior position with goal of satisfactory overjet / overbite and elimination of functional displacement. Considerations in treatment planning include:

• Space Available
• Severity of Displacements
• Mandibular Incisor Positioning
• Stage of Eruption/Access
• Eliminate Local Etiology
• Maxillary Incisor Inclination
• Overbite
• Cooperation
• Patient cooperation
BIOMECHANICS / APPLIANCES:

- Popsicle Stick - Guide plane concept. Worth try if lingual malpositioning recognized in early transition.
- Mandibular Inclined Plane - Do not recommend due to trauma consequences.
- Removable Maxillary Hawley with fingerspings (.020 double-helix) to labialize involved maxillary teeth. Incorporates posterior biteplane to seat appliance, decrease anterior interferences for labial tooth movement. Bonded lingual composite “button” on crossbite incisor to engage spring.
- Fixed Lingual Arch Wire (.036 S.S.) from bands on first permanent molars with fingerspring (.020 double-helix) to labialize involved maxillary teeth. Bonded lingual composite “button” on crossbite incisor to engage spring. **Preferred approach**
- Labial Archwires / Brackets - In conjunction with other major incisor alignment needs. Mx. 2 X 4 advancement with stopped archwires (NiTi & Guren locks, omega loops on S.S. wire).

STRATEGIC PRIORITY #1 ➔ “Correct” Anterior Openbite / Deleterious Extraoral Habits

**DEFINITION** - Prolonged digit (thumb, finger) or pacifier habit producing dentoalveolar changes.

**SIGNIFICANCE OF HABIT DURATION TO OCCLUSION:**

- **Age / Habit ➔ Malocclusion**
  - Before Age 4 Years -- Probably no long-term effects, possible posterior crossbite.
  - Four to Six Years --? Dependent on Duration, Frequency, Intensity
  - Mixed Dentition -- Malocclusion Likely
- **Effects On Occlusion**
  - Flaring of Maxillary Incisors / Lingual Inclination of Mandibular Incisors
  - Anterior Openbite - disrupted incisor eruption / distorted occlusal plane anteriorly.
  - Increased Overjet
  - Distortion of Maxillary Alveolar Process
  - Posterior Crossbite -- Definite association if habit prolonged to transitional dentition.
  - Class II Molars (?)
  - Alteration of Basal Bone (?)
- **Abnormal Muscle Activity**
  - Tongue Thrust - almost always with openbite
  - Perioral: Lip Habit, Mentalis with tongue thrust and overjet / openbite

**DIAGNOSIS OF HABIT SIGNIFICANCE:**

- Patient History/Parental Interview - Duration, Frequency, Intensity, Motivation of Patient / Parents.
- Perioral Musculature / Soft Tissue Patterns >> Lip Habit, Mentalis
- Occlusion - Openbite, Overjet, Molar Relations, Posterior Crossbites, Palatal Constriction
- Associated Habits, e.g. tongue thrust swallowing
- Differentiate Dental vs. Skeletal Openbite / Overjet - Distinguish airway complications.

**TREATMENT:** Eliminate extraoral habit and control tongue thrust swallowing to enhance potential for “self-correction” of incisor malpositioning. Step-wise protocol dependent on patient age & cooperation:

- Watchful Waiting: Suggested below age 4 years of age.
- Rewards - first choice 4 to 6 years of age using calendar “star” reward program for three months.
- Mechanotherapy: Palatal Crib - once incisors in transition, 6 to 10 years of age. **Preferred**
  - Crib serves as reminder, interferes with digit placement, restrains forward tongue position.
  - Promotes incisor self-alignment and eruption.
  - Planned for six-months wear, habit usually ceases within weeks.
- Corrective Orthodontics: Mechanically align dentition in conjunction with Crib therapy.
  - May be necessary in some mixed dentition cases with 2 X 4 mechanics.
  - Usually necessary in late mixed dentition or adolescent patients.
- ENT Referral – if airway compromise / tongue thrust without digit habit diagnosed
- Myofunctional – speech problems with referral / consult to speech therapist.
STRATEGIC PRIORITY #1 ➔ “Correct” Posterior Crossbites

DEFINITION: Posterior dentition (canines, primary molars, permanent molars, bicuspid) in transverse displacement with upper arch lingual to lower (5 - 8 % of children). If upper dentition buccal to lower, called buccal crossbite or “Brodie Bite” (< 1 %).

- **Dental**: Isolated dental malpositioning - usually only 1 or 2 teeth.
- **Functional**: Lateral shift of mandible on closure due to uncoordinated upper to lower arch widths - usually inadequate maxillary. Up to 90-95% of posterior X-bites in children evidence a functional component that is associated with:
  - Lower midline shift to crossbite side (≈ 2 to 3 mm.) as mandible deviates on closure.
  - Unilateral lingual crossbite of entire buccal segment from canines back in C.O.
  - Asymmetric Class II molars on crossbite side, Class I non-crossbite side.
  - Asymmetric condylar position - rotates around condylar axis on crossbite side, down and forward on non-crossbite side.
  - Facial asymmetry / chin deviation – strong evidence mandible “grows” short on crossbite side, longer on non-crossbite side for true skeletal asymmetry long-term.
- **Skeletal**: True transverse discrepancy - usually presents as bilateral crossbite with severely constricted upper arch, high palatal vault, midline coincidence.

DIFFERENTIAL DIAGNOSIS: Evaluate CR-CO differences for following variables -

- Midline Coincidence >>> Lower to upper alignment, stays same or changes on closure..
- Mandibular Shift >>> Must Discriminate - Unilateral vs. Bilateral in C.O. vs. C.R.
- Number of Teeth Involved >>> Single vs. Multiple Teeth / Whole Buccal Segment
- Sidedness >>> Unilateral / Bilateral Crossbite, Molar Classification, Facial Symmetry

TREATMENT OBJECTIVES: Establish -

- Normal intraarch symmetry and shape
- Coordinated interarch relationships with transversely and A-P symmetry
- Eliminate functional displacements (i.e. allow normal closure, TMJ positioning balance)

TREATMENT PLANNING CONSIDERATIONS:

- Stage of Dentition - Primary, Mixed, Adolescent - Eruption Status / Appliance Retention
- Arch Length / Circumference - Amount of expansion needed, associated alignment objectives.
- Nature of Expansion - Orthodontic / Orthopedic
- Habits / Overbite / Overjet
- Nature of Expansion - Orthodontic / Orthopedic
- Molar Rotations & Archform
- Facial Type
- Patient Age / Cooperation

APPLIANCE OPTIONS:

- **Cross-arch Elastics**: Isolated dental displacements – extrusion and cooperation problems.
- **Removable Schwarz Plate**: Limited transverse dental expansion / lateral up-righting. Rarely used.
- **Quad-helix Appliance**: For functional crossbites in primary and early to mid-mixed dentitions. Band E’s in the primary dentition, band 6’s in mixed dentition. Utilize 0.036 S.S. with directed horizontal helical loops to maximize orthopedic change & reduce lateral dental tipping. **Preferred approach.**
- **Hyrax Rapid Palatal Expander**: Fixed jackscrew appliance to optimize orthopedic sutural expansion – bilateral posterior crossbite and late mixed dentition once bicuspsids in transition. Four-point banded Hyrax preferred > Band 6 - E in mixed dentition, 6 – 5 in permanent dentition unless not available, then 6 - 4. Consider hinged E-spyder for tapered arch collapse, enhanced anterior expansion, molar rotation. **Preferred approach.**
STRATEGIC PRIORITY #2: Arch Development with Increased Arch Dimensions

**Rationale:** Development of increased arch dimensions through anteroposterior arch lengthening by molar distal movement and/or incisor forward positioning as well as transverse arch expansion in intermolar and intercanine arch width is most readily achieved during the transitional dentition.

**Significance:** Development of increased arch dimensions for the purpose of gaining space to relieve crowded dentitions, to increase the vertical support of the occlusion, and to position the dentition optimally within the dentofacial framework offers esthetic and functional advantages in the majority of orthodontic patients. Arch development is particularly applicable in mesofacial and brachyfacial cases where extraction modalities are more likely to compromise esthetic and functional objectives.

**Biomechanics:** Arch development for the purpose of increased space involves:

- Ensuring no secondary space loss using space maintenance procedures and the optimal use of inherent leeway space by controlling late mesial shift transitional arch dimension changes.
  - Use lower lingual holding arches and upper transpalatal bars or Nance appliances placed just prior to exfoliation of the second primary molars and eruption of second premolars.
  - May incorporate selective extraction of primary molars in conjunction with bilateral space maintainers to facilitate premolar eruption.

- Transverse expansion of the maxillary arch with a basal / sutural emphasis.
  - Quad-helix in the primary and early mixed dentitions.
  - Banded Hyrax in selected primary and mixed dentition cases (bilateral crossbites).
  - Four-point Banded Hyrax in the mid-mixed, late-mixed, and adolescent permanent dentitions.

- Distalization, rotation, and holding of maxillary first molars to secure Class I positioning.
  - Fixed-removable transpalatal bar (Goshgarian).
  - Halterman Appliance (Ectopic eruption of first molars).
  - Cervical-pull headgear for bodily distal movement of molars and anchorage.
  - High-pull headgear for distal root movement of first molars and restraint of A-P movement.

- Positioning of upper and/or lower incisors forward with segmental 2 x 4 appliances if the presenting facial patterns and periodontal considerations will support the A-P movement.
  - Utility intrusion / protraction archwires.
  - Sliding mechanics (coilsprings, archwire locks / NiTi wire, elastic chains).

- “Expanding” mandibular arch-width through control of muscle forces to enhance eruptive expansion and up-righting of lingually collapsed lower arches.
  - Passive expansion secondary to maxillary expansion.
  - Bihelix in mixed dentition with lingual collapse.
  - Lip bumpers during late buccal transition.

- Positioning incisors forward and the buccal segments laterally with full archwires in the adolescent dentition while striving to maintain coordinated archforms using the lower arch width as a template for upper to lower arch symmetry.
STRATEGIC PRIORITY #3: Transverse Maxillary Expansion

Rationale: The transverse dimension is the first dimension to be complete in facial growth with the maxillary shelves beginning to interdigitate in the early teens and progressive interlocking taking place until fusion begins in young adulthood. Basal orthopedic correction emphasizing mid-palatal sutural separation is much easier to achieve and more stable when accomplished in the primary, mixed, and young adolescent dentition stages than in the mid-teens to adulthood.

Significance: Transverse discrepancies are characteristic of skeletal malocclusions for both Class II and Class III growers as well as patients with constricted maxillary arches associated with posterior crossbites, airway/mouthbreathing patterns, and digit habits. In addition, proper maxillary arch width coordination with the lower arch ideally finds the upper dentition with a lingual oriented buccolingual inclination for optimal functional occlusion and dentofacial esthetics.

- Maxillary expansion optimizes the developmental environment for mandibular function and growth in the majority of Class II, Division 1 patients.
  - Promotes development potential by “unlocking” the mandibular occlusion.
  - Frees the mandible from possible retrusion and restriction of forward positioning.
  - Concurrently increases mandibular arch width.
- Maxillary sutural expansion promotes maximal growth of the upper apical base.
  - Increases arch dimensions to enhance tooth alignment.
  - Enhances forward development of maxilla in Class III correction.
  - Increases anterior perimeter to enhance dentofacial esthetics - broadens the smile.
  - Increases intercanine arch width to optimize eruptive positioning and alignment of palatally displaced maxillary canines.
  - Enhances potential for improved airway and nasal respiration.
- Maxillary sutural expansion enhances arch coordination in the horizontal plane.
  - Basal expansion allows normal vertical closure in functional crossbites.
  - Basal expansion enhances transverse coordination of occlusal relationships by allowing proper lingual inclination of buccal segments.
  - Enhances correction of asymmetry by minimizing functional components.

Biomechanics: Appliances typically used are designed to emphasize bony basal expansion at the mid-palatal sutural levels over lateral expansive tipping of dental units. Accomplished through selected force applications and appliance designs appropriate to patient age and dentitional development.

- Slow, low-force mechanics in the primary to mid-mixed dentition (Quad-helix) is adequate for a combination of sutural and dental expansion changes.
- Rapid palatal expansion employing high-force mechanics in the mid- to late mixed dentition and young permanent dentition (Banded Hyrax – usually a four point design).
- Banded Hyrax in selected primary to mid-mixed dentition stages (bilateral crossbites, anchorage for reverse pull facemask in Class III correction protocols).
- Surgically assisted expansion in adults.

Dental arch expansion and retention of orthopedic sutural effects are supported during Edgewise phase with transpalatal bars, rigid archwires, headgear facebow, E-arches and Schwarz plates.
STRATEGIC PRIORITY #3 (con’t)  “Age-Appropriate” MAXILLARY EXPANSION ⇒ Do It Early!

RATIONALE: The transverse dimension is the first dimension to be complete in facial growth. Basal orthopedic correction with mid-palatal sutural separation is usually the desired emphasis of maxillary expansion procedures to correct basal transverse discrepancies over lateral dental expansion effects. Sutural palatal expansion is much easier to achieve and more stable if accomplished in the primary, mixed, and adolescent dentitions.

Transverse discrepancies are characteristic of skeletal malocclusions for Class II and Class III growers as well as in constricted maxillary arches associated with posterior crossbites, airway and mouthbreathing patterns, and eruption anomalies associated with displaced buccal segments and impacted maxillary canines.

Maxillary expansion enhances arch coordination in the **horizontal plane** to allow normal mandibular closure patterns. Basal directed expansion with balanced orthopedic and orthodontic effects promotes maximal growth of the upper apical base to:

- Allow normal vertical closure in functional posterior crossbites with enhanced correction of asymmetry by minimizing mandibular deviations in harmonizing TMJ positions.
- Enhance transverse coordination of occlusal relationships by allowing proper lingual inclination of buccal segments – minimizes balancing side contacts.
- Enhance potential for improved airway and nasal respiration, proper tongue positioning.
- Increase arch dimensions for enhanced tooth alignment.
- Increase anterior perimeter to enhance dentofacial esthetics (broadens smile).
- Increases intercanine arch width to optimize eruptive positioning and alignment of palatally displaced maxillary canines.

Maxillary expansion optimizes the developmental environment for mandibular function and growth in the **anteroposterior plane** in the correction of Class II and Class III malocclusions.

- Class II, Division 1 – Maxillary expansion promotes development potential by “unlocking” the mandibular occlusion and freeing the mandible from retrusion / restriction of positioning.
- Class III - Enhances forward development of maxilla in Class III correction and coordinates maxillary arch width to compensate for bilateral arch collapse.

BIOMECHANICS: Selected appliances are designed to emphasize bony basal expansion at mid-palatal sutural levels over lateral dental expansive tipping responses through directed force applications and appliances appropriate to patient age and dentitional development.

- Slow, low-force mechanics in the primary to mid-mixed dentitions are appropriate for a combination of orthopedic and dental responses (**Quad-helix, W-Arch**).
- Rapid palatal expansion using high-force mechanics in the mid- to late mixed and young permanent dentitions are indicated to prioritize orthopedic emphasis. **Multiple-banded Hyrax designs (Four-point) are** advocated in the primary and mixed dentition cases with bilateral crossbite presentations and in the young permanent dentition until sutural development is complete.
- Dental arch expansion and retention of orthopedic sutural effects are supported with transpalatal bars, rigid archwires, headgear facebow, E-arches and Schwarz plates.
STRATEGIC PRIORITY #4: Control of Functional Problems

Rationale: Functional deviations in mandibular movement on opening and closing, perioral lip and tongue patterns at resting positions and in function, airway considerations, oral habits with deleterious effects, and temporomandibular dysfunction all have potential environment affects on dental arch development, craniofacial growth, and functional harmony.

Significance: Conceptually, functional problems should always be addressed as primary and significant etiological factors in the diagnosis of malocclusion and as potential modifiers of treatment progress and stability. If you see a functional problem, fix it.

Biomechanics: Appliance choices directed at coordinating the shape of the arches for enhanced functional occlusion or appliances designed to restrain atypical muscle forces that are complicating normal dentitional development are utilized to minimize and hopefully eliminate the functional problems.

- **Functional mandibular deviations**
  - Maxillary expansion in lateral functional crossbites. If untreated, asymmetric mandibular growth is a probable consequence.
  - Maxillary dental protraction in dentoalveolar anterior crossbites with forward mandibular displacement (Pseudo-Class III patterns). If untreated, excessive mandibular growth or restricted maxillary forward development may be a consequence of the anterior deviation.
  - Mandibular advancement appliance in extreme Class II “dual-bite” retrusion.

- **Deleterious Digit Habits (Thumb and finger-sucking habits)**
  - Stop digit habits and associated “simple” tongue-thrust swallowing with palatal crib appliances.
  - Must discriminate openbite malocclusion associated with localized functional effects from medically related airway problems and true hereditary vertical growers – these are not candidates for palatal crib type appliances that might compromise necessary functional patterns.

- **Perioral Habits**
  - Eliminate lip interpositioning in Class I patterns by retraction of excessively protrusive incisors or utilize mandibular lip bumper to “retrain” lip muscles and allow forward movement of lower incisors.
  - Utilize mandibular advancement appliance in Class II mandibular retrusion.

- **TMJ Dysfunction**
  - Assess etiological factors - trauma, stress, bruxism, functional occlusion.
  - If related to excessive deepbite, flare maxillary incisors and support with anterior biteplane to protect the vertical development.
  - With significant clicking and/or popping and dysfunction as a sign of disk displacement, consider anterior repositioning splint or mandibular advancing functional appliance.
  - With pain and no clicking or popping as a sign of disk displacement, consider superior repositioning “relaxation” splint or simple Hawley with anterior biteplane.
STRATEGIC PRIORITY #5: CONTROL OF VERTICAL DEVELOPMENT

Rationale: The hardest problem to correct and maintain in orthodontic treatment, particularly if correction is started after growth is complete; is the excessive development of dental and skeletal tissues in the vertical plane. It is easier to control vertical development in association with transitional eruption timing than to correct established vertical positions.

Significance: While theoretically possible, little documentation exists that it is clinically possible to predictably intrude teeth to compensate for excess vertical eruption. The key to control of the vertical plane is to hold or restrain dental eruption through segmental mechanics while allowing adjacent segments to develop vertically. This relative intrusion that is accomplished by restraining the eruption of selected teeth while allowing or even enhancing the eruption of others results in the appearance of intrusion of the restrained teeth.

For skeletal dolichofacial growth patterns with characteristic excessive vertical development, restraint and/or redirection of the maxillary skeletal growth from its' normal down and forward path as well as control of the normal eruptive development of the maxillary dentition through directed force applications up and back toward sutural planes offers the best hope for vertical control in the growing patient.

Similar diagnostic and treatment concepts hold true for patients with brachyfacial deep-bite growth patterns as in dolichofacial growth patterns except that mechanical options are directed at enhancing vertical development during growth rather than restraining vertical growth and development. Again, such deepbite patterns with brachyfacial growth patterns typically present excessive occlusal bite pressures and muscle functions that can overwhelm bite-opening mechanics and/or present a strong relapse tendency back toward deepbite patterns.

Biomechanics:

• **Excess vertical development** is controlled primarily through the combination use of:

  • High-pull headgear to restrict maxillary dental eruption and restrain maxillary growth from following normative down and forward movement patterns.

  • 2 x 2 and 2 x 4 mechanics utilized for relative incisor "intrusion".

  • Transpalatal bar attached to maxillary molars to restrict vertical eruption. Similar restraint of lower molar vertical eruption may occur with application of a lingual holding arch appliance.

  • Posterior biteplanes to restrict eruption of occluded buccal segment teeth.

  • Extraction protocols over arch development in crowding cases.

• **Deep-bite skeletal malocclusions** with short anterior face height receive enhanced vertical development through the use of:

  • Cervical pull headgear to enhance vertical eruption of the dentition and increase anterior face height through increased mandibular plane opening.

  • Anterior biteplanes to “restrain” the anterior segment vertical eruption while allowing enhanced posterior eruption.

  • Lower arch leveling through second permanent molars with full appliances.

  • Arch expansion over extraction protocols as management approach in crowding cases.
RATIONALE: The objectives of esthetics and functional harmony can rarely be achieved without significant compromise unless basal relationships are in Class I orthognathic A-P positions with coordinated upper to lower transverse arch widths and normative incisor coupling. By definition, one must treat during active growth periods to modify growth – this implies that growth modification treatments to change dentofacial orthopedic relationships should be done in conjunction with the pubertal growth spurt or earlier for optimal results.

PRIORITY BIOMECHANICS: Treatments should employ orthopedic and orthodontic actions that most directly attack the area of discrepancy to influence growth patterns in all three planes of space. As examples, Class II, Division 1 malocclusions most often present with mandibular retrognathia, a vertical dolichofacial growth tendency, and narrowed upper archform. Class III malocclusions typically present a combination of maxillary retrognathia and mandibular prognathia, a vertical excess growth pattern, and a notable transverse maxillary arch deficiency. Addressing each of these dimensional needs is critical to “early” treatment success.

**Transverse Maxillary Basal Expansion** - All Class II, Division I malocclusions must be assessed for maxillary expansion - often required to allow for mandibular advancement. Estimated 50% of Class II’s have constricted arch-width that is already expressed in the primary dentition with distal-step relationships. Orthopedic “sutural” expansion of bony base generally desirable over orthodontic expansion, so age and biomechanics critical in maximizing orthopedic response – *do early.*

**Anteroposterior Skeletal Class II @ age 9 to 12 years (mixed dentition)**

- **Moderate mandibular retrognathia:** ANB of +4 to +8 degrees, Mx. - Md. Difference of 15 - 20 mm.
  - > Meso- to brachyfacial grower >> Cervical-pull HG / Biteplane combination
  - >> Twin-force Bite Corrector on full Edgewise
  - > Dolichofacial high-angle grower >> Activator / High-pull HG combination

- **Severe mandibular retrognathia, ANB > +8 degrees, Mx. – Md. Difference < 15 mm.**
  - ⇒ advance the mandible with protrusive bite, provide “headgear effect”
  - > Brachyfacial low-angle grower, mixed >> Orthopedic Corrector
  - > Dolichofacial high-angle grower, mixed >> Activator-Headgear Combination
  - > Mesofacial to brachyfacial, adolescent >> Herbst Appliance

- **Protrusive Maxilla - Restrain with directed cervical or high-pull headgear**
  - > Meso- to brachyfacial grower, mixed ⇒ Cervical-pull HG
  - > Dolichofacial high-angle grower, mixed ⇒ High-pull HG

**Anteroposterior Skeletal Class II @ age 11 to 15 years (adolescent)**

- **Mild to moderate mandibular retrusion, minimal growth, adolescent – O.K. profile**
  - > Mesofacial to brachyfacial, adolescent ⇒ Class II elastics,
    ⇒ Twin-Force on full Edgewise
    ⇒ Herbst with Edgewise stage
    ⇒ Camouflage, upper 4 – 4 extraction
    *Could be after any of the above*

- **Notable mandibular retrusion, minimal growth, adolescent – Retrognathic profile**
  - > Mesofacial to brachyfacial, adolescent ⇒ Twin-Force on full Edgewise
    ⇒ Herbst Appliance & hope!
STRATEGIC PRIORITY #6 ➔ CLASS II TREATMENT MODALITIES, Non-Extraction Options

1. Extraoral Headgear / Growth Modification
   - “Redirects or restrains” maxillary growth so mandible may catch up in A-P correction.
   - Effects exerted on teeth and/or orthopedically on maxilla depend on variables in force application (direction of pull, magnitude, duration, timing as to age, dentitional anchorage).
   - Expansion and occlusion cuspation changes may enhance forward mandibular positioning.

2. Growth Modification With Functional Appliances
   - May enhance favorable mandibular length and condylar growth.
   - May eliminate atypical muscle function (lip interpositioning, mentalis – a “big” plus).
   - May restrain maxillary development (“headgear effect”).
   - Allows transitional dentition treatment just before and during pubertal growth spurt.

3. Overt Maxillary Buccal Segment Distalization – not a fan of these procedures.
   - Excess molar crown distalization (tipping) contradicts proper angulations for stable occlusion.
   - Creates reciprocal anterior forces with possible excess protrusion - need extensive anchorage.
   - Molar distalization creates eruption and alignment problems for second molars.
   - Not indicated in patients who cannot tolerate rotation of the mandible, bite opening.

4. Interarch Class II Elastics and/or Interarch Fixed “Trombone” Components (e.g. Twin-Force)
   - Creates anteroposterior and vertical forces for tooth movement, questionable orthopedics.
   - Requires anchorage - avoid excess lower proclination, molar extrusion, upper anterior extrusion.
   - Not indicated in patients who cannot tolerate rotation of the mandible, bite opening.

CLASS II CORRECTION ➔ EXTRAORAL HEADGEAR

Indications for Extraoral Headgear

1. Maxillary protrusion (skeletal, dental) where retraction will not compromise nasolabial profile.
2. Distalization of buccal segments to gain arch length and optimize Class I molars desired.
3. Use as anchorage support for canine and/or incisor retraction.
5. Timing of growth - Patient in active growth - on upward slope or just beyond peak of growth curve.
6. Arch expansion desirable to enhance forward movement of mandible.

Objectives of Extraoral Headgear

1. Restrain maxillary growth and control molar eruption patterns.
2. Distalize upper molars with controlled bodily versus tipping movements to gain A-P arch length.
3. Expand maxillary arch to “unlock” occlusion for mandibular forward movement.
4. Anchorage support for upper buccal segments during incisor/canine retraction.

Considerations in Selecting Extraoral Headgear Design – Assuming proper timing

1. Direction of growth - deepbite vs. openbite patterns.
2. Maxillary growth restraint versus dental retraction – what are most desired effects.
3. Direction of force – High-pull versus cervical traction.
4. Magnitude of force - Lighter forces (8-12 ounces) versus heavier forces (16-20 ounces).
5. Duration of force - Half-time (10-12 hours per day) versus “full-time” (16 - 20 hours per day)
CERVICAL PULL HEADGEAR - To enhance vertical development along with distalization of the upper molars, as well as influence maxillary growth (deepbite, brachyfacial).

• Promotes extrusion & distalization of molar crowns (tipping) - average 3 mm./year distalization.
• Can be modified in facebow orientation to balance crown and root effects in distalization.
• Produces potential “shearing” effect at the sutures to influence displacement of the maxillofacial complex > effects about 0.5 to 1.0 mm. distal movement of A–point through maxilla skeletal restraint.
• Increases lower face height - FMA is increased, pogonion drops down and back as bite opens.

Cervical-Pull Headgear: Set-up
- Inner bow to six-year molar tubes with slight expansion of 2-3 mm.
- Medium length outer bow (at about A-P level of buccal tubes) elevated above occlusal plane 30 to 45 degrees sets up molars for more balanced bodily crown-root control in distal movements.
- Force levels of 12 to 16 ounces per side, wear 12 to 14 hours per day (at home - bed, TV).
- Usually about six months of cooperative wear, sometimes one-year necessary.

NOTE WELL: Cervical pull headgear may be used with Hawley anterior biteplane for mixed dentition deepbite, Class II cases. May also incorporate in a 2x4 setup.

HIGH-PULL HEADGEAR: To restrict vertical eruption of molars, enhance bodily control of molars, and restrain maxillary growth to “allow” mandible to catch-up while minimizing bite opening (hyperdivergent, patients).

• Promotes horizontal bodily dental movement of molars, but distalization effects are minimal.
• Restrains vertical & forward development of molars (I.e. relative “intrusion” of molars).
• Restrains downward/forward growth of maxilla, more so posteriorly at PNS than anteriorly at ANS.
• Minimizes FMA and lower face height changes to reduce bite opening.

High-Pull Headgear: Set-up
- Inner bow to six-year molar tubes with slight expansion of 2-3 mm.
- Short length outer bow (about A-P level of first bicuspid / first primary molar) elevated above the occlusal plane about 30 degrees. Maximizes molar bodily restraint & maxilla development.
- Force levels of 14 to 16 ounces per side, wear 10 to 12 hours per day.
- Usually requires about one-year of cooperative wear.

NOTE WELL: High-pull headgear may be used in combination with Activator for mixed dentition vertically sensitive Class II cases. May also incorporate 2x4 setup.

EXTRAORAL HEADGEAR & CLASS II CORRECTION

<table>
<thead>
<tr>
<th></th>
<th>CERVICAL PULL</th>
<th>HIGH PULL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary Orthopedic Restraint</td>
<td>0.5 to 1.0 mm.</td>
<td>1.0 mm.</td>
</tr>
<tr>
<td>Maxillary Dental Retraction</td>
<td>3.0 mm.</td>
<td>1.0 mm.</td>
</tr>
<tr>
<td>Mandibular Dental Protraction *</td>
<td>? (Leeway)</td>
<td>? (Leeway)</td>
</tr>
<tr>
<td>Increased Mandibular Growth **</td>
<td>1.0 mm.</td>
<td>1.0 mm.</td>
</tr>
<tr>
<td>Total A-P</td>
<td>4.0 to 5.0 mm.</td>
<td>3.0 mm.</td>
</tr>
</tbody>
</table>

* Lower molar forward movement into the leeway E-space effects A-P molar relationships.
** In both cervical and high-pull regimes, the mandibular occlusion can become “unlocked” and result in mandibular growth of approximately +1 mm. more than would be anticipated without headgear intervention.
GROWTH MODIFICATION ➔ FUNCTIONAL APPLIANCES (Mandibular Advancement)

Indications For Functional Appliances

1. Mandibular retrognathia with favorable growth pattern (Meso - to Brachyfacial)
2. Minimal crowding problems, symmetrical arches, incisors not proclined
3. Patient in active growth - on upward slope of curve approaching peak
4. Mandibular advancement enhances the facial profile and vertical balance
5. Airway not compromised
6. Cooperative / understanding patient and family

Objectives Of Functional Appliances

1. Restore good anatomic occlusion with a protected functional articulation
2. Restrain maxillary dentition and advance lower dentition - control eruption patterns.
3. Create well-balanced soft tissue equilibrium with pleasing facial esthetics
4. Stimulate condylar “growth” and/or restrain maxilla forward development.

Considerations In Selection of Functional Appliances

1. Direction of growth – deepbite / horizontal favorable vs. vertical / openbite contraindicated.
2. Timing of growth - on upward slope or just beyond peak of growth curve for best response.
3. Expression of change desired (hard vs. soft tissues, dental vs. skeletal changes, maxilla (fibrous articulations) vs. mandibular emphasis (cartilaginous articulations)
4. Stage of dentition (mixed versus adolescent) as to buccal transition, anchorage for appliances.
5. Amount of discrepancy - Full versus half Class II, lower arch spacing (E-space).

Dentofacial Orthopedic - Orthodontic Results Attributed To:

1. Stimulation of condylar growth (Frankel, McNamara) and glenoid fossa remodeling (Harvold) through postural changes in muscle, bone, & cartilage relationships via mandibular advancement.
2. Stimulation of perioral and muscles of mastication in affecting dentoalveolar changes by protracting the mandibular dentition and retracting / restraining the maxillary dentition (Harvold).
3. Change in direction and amount of maxillary growth (Harvold).
4. Dentoalveolar remodeling influences growth adaptation by “unlocking” occlusion and allowing mandible to reach growth potential (Bjork, Woodside).

FUNCTIONAL APPLIANCES AND CLASS II CORRECTION

One Can Expect With One Year of Cooperative Functional Appliance Wear:

<table>
<thead>
<tr>
<th>Description</th>
<th>Range</th>
</tr>
</thead>
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</tr>
<tr>
<td>Mandibular Dental Protraction</td>
<td>1.0 to 2.0 mm.</td>
</tr>
<tr>
<td>A-P TOTAL</td>
<td>3.0 to 6.0 mm.</td>
</tr>
</tbody>
</table>
FUNCTIONAL APPLIANCES OF CHOICE: Rationale for Selection and Design

Orthopedic Corrector

- To maximize A-P mandibular growth and increase lower anterior face height.
- Indicated in brachyfacial, deepbite cases with significant horizontal growth potential.
- Timing in mid- to late transitional dentition in conjunction with pubertal growth spurt.
  - Advance incrementally with 3 mm. protrusive adjustments at 3-month intervals.
  - Open vertically approximately 3-4 mm.
  - Cap lower incisors, design buccal coverage according to eruption, leveling needs.
  - “Full time” wear.
  - Anticipate one year of wear.

Activator / Headgear Combination

- To advance mandibular A-P growth and restrain vertical development of maxilla.
- Indicated in hyperdivergent / dolichofacial tendency cases with vertically oriented growth potential.
- Timing in mid- to late transitional dentition in conjunction with pubertal growth spurt.
  - Advance to incisor end-on A-P positioning.
  - Open vertically encroaching into “freeway” space (4 - 6 mm.).
  - Cap lower incisors, cap maxillary posterior dentition, design lower posterior coverage according to eruption/leveling needs.
  - Bands on 6’s for headgear with C-clasps off activator for retention.
  - Wear 12-14 hours per day
  - Anticipate one year of wear

Herbst Appliance

- To advance mandibular dentition and mandibular growth while distalizing upper dentition.
- In deepbite, Class II malocclusion.
- During the very late transitional dentition or full adolescent dentition with problematic growth timing left - adolescents at peak or on downslide of growth curve.
  - Initial advancement of approximately 3 mm.
  - Prefer removable components for lower arch, use upper Hyrax base appliance if maxillary expansion required with banded first molars and first bicuspids. Place the lower advancement component at completion of active maxillary expansion.
  - Option is upper and lower fixed with full stainless steel crown coverage or “reinforced” bands on both upper and lower first molars as anchorage for Herbst arms and extensions.
  - Fulltime wear for 6 months to one year.
  - Incremental advancement of 3 mm. at three months until edge-to-edge.
  - Can advance asymmetrically – one of the major appliance advantages.
## CLASS II BIOMECHANICS: SUMMARY OF TREATMENT EFFECTS

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Profile Change</th>
<th>Maxilla</th>
<th>Mandible</th>
<th>Mx. molars</th>
<th>Md. molars</th>
<th>Mx. Incisors</th>
<th>Md. Incisors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cervical headgear Solo 6-6</strong></td>
<td>1. Flatter upper lip, possible lower as well 2. Increase LFH</td>
<td>1. Possibly held back 0.5 mm/yr 2. Possible A-point reduction</td>
<td>1. Minimal A-P length change 2. Increase FMA autorotation</td>
<td>1. Distalized w/ tipping 2. Extruded</td>
<td>Same as normal growth</td>
<td>Same as normal growth</td>
<td>Same as normal growth</td>
</tr>
<tr>
<td><strong>Cervical headgear/ Anterior Biteplane</strong></td>
<td>1. Flatter upper lip, possible lower as well 2. Increase LFH 3. Possible more chin expression</td>
<td>1. Possibly held back 0.5 mm/yr 2. Possible A-point reduction</td>
<td>1. Slight A-P length change of 0.5 mm./year 2. Increase FMA autorotation</td>
<td>1. Distalized w/ tipping 2. Extruded, reduced compared to solo CPHG</td>
<td>Same as normal growth</td>
<td>Tipped lingually</td>
<td>Reduced eruption, possibly proclined</td>
</tr>
<tr>
<td><strong>High-pull Headgear Solo 6-6</strong></td>
<td>1. Normal growth or possible slight straightening 2. Possibly reduce LFH</td>
<td>1. Held from growth 2. PNS up from ANS 3. A-point back</td>
<td>1. Minimal A-P length change 2. No change vertically</td>
<td>1. Held from vertical dev. 2. Distalized bodily</td>
<td>Same as normal growth</td>
<td>Same as normal growth</td>
<td>Same as normal growth</td>
</tr>
<tr>
<td><strong>Orthopedic Corrector / Bionator</strong></td>
<td>1. Enhanced chin - reduced profile convexity 2. Reduced mentalis / lip protrusion 3. Increase LFH</td>
<td>Normal growth with possible slight restraint A-P &amp; vertical (do not expect)</td>
<td>1. Increase AP growth = 1 mm. per year. 2. Increase FMA</td>
<td>Normal A-P possibly hold in place</td>
<td>Normal A-P Possible + protraction</td>
<td>Tipped lingually</td>
<td>Proclined</td>
</tr>
<tr>
<td><strong>Activator / High-pull Headgear Combo.</strong></td>
<td>1. Flatter upper lip protrusion 2. Reduced mentalis / lower lip protrusion 3. Stable LFH</td>
<td>Restrained AP &amp; downward growth = 1 mm. per year.</td>
<td>1. Slight A-P length change of 0.5 – 1 mm. yr. 2. No change vertically - same FMA</td>
<td>1. Held from vertical dev. 2. Distalized bodily</td>
<td>Normal A-P Possible + protraction</td>
<td>Tipped lingually</td>
<td>Proclined</td>
</tr>
<tr>
<td><strong>Fixed Herbst Appliance</strong></td>
<td>1. Enhanced chin - reduced profile convexity 2. Reduced mentalis, U/L lip protrusion 3. Increase LFH</td>
<td>Restraint of AP &amp; downward growth = 0.5 mm. per year.</td>
<td>1. Increase AP growth = 1 mm. per year. 2. Increase FMA</td>
<td>1. Held from vertical dev. 2. Distally tipped crown</td>
<td>1. Forward 2. Probably extruded, may restrict eruption</td>
<td>Minimal change to possible lingual tip</td>
<td>Proclined</td>
</tr>
<tr>
<td><strong>Edgewise Class II Elastics</strong></td>
<td>1. Expect no major change 2. Upper lip may flatten if incisors retroclined</td>
<td>No change with possible slight extrusion of anterior at ANS</td>
<td>1. Possible slight autorotation to increase FMA 2. Functional posturing likely</td>
<td>No change</td>
<td>1. Forward positioning 2. Extrusion</td>
<td>Directional distal tip &amp; extrusion</td>
<td>Directional proclined</td>
</tr>
<tr>
<td><strong>Edgewise Upper 4-4 Extraction</strong></td>
<td>1. Flat upper lip, lower protrusion 2. Normal growth or possible slight straightening</td>
<td>No change with possible slight extrusion of anterior at ANS</td>
<td>No change</td>
<td>1. Forward to Class II 2. Probably extruded</td>
<td>Same as normal growth</td>
<td>Distalized, up-righted, extruded</td>
<td>Proclined</td>
</tr>
<tr>
<td><strong>Edgewise U / L 4X4 Extraction</strong></td>
<td>1. Flatter upper &amp; lower lip profile 2. Reduced LFH</td>
<td>No change with possible slight extrusion of anterior at ANS</td>
<td>No change with possible slightly reduced FMA</td>
<td>1. Forward 2. Probably extruded</td>
<td>1. Forward 2. Probably extruded</td>
<td>Distalized, up-righted, extruded</td>
<td>Distalize, up-righted, extruded</td>
</tr>
</tbody>
</table>
STRATEGIC PRIORITY #6: Dentofacial Orthopedics ➔ SKELETAL CLASS III MALOCCLUSIONS

In terms of dentofacial orthopedics, the basic treatment options for true Class III skeletal malocclusions are to protract the maxillary complex with forward repositioning, expand the maxilla with sutural separation, restrain or redirect growth of the mandible, attempt to influence A-P dental positions (protract upper dentition, retract lower dentition) or to camouflage the A-P discrepancy using various extraction protocols. The fundamental objectives of these various treatment options in the growing patient are to:

- Correct reverse anterior overjet and establish proper overbite in achieving reasonable anterior coupling.
- Relief of dental crowding and irregularities.
- Enhance the profile and facial esthetics toward orthognathic balance.
- Control excess or deficient growth areas through growth modification.
- Correct the Class III molar and buccal segment discrepancy – implies Class I canines, incisal guidance.

Correction option(s) in achieving these goals are dependent on growth patterns and facial typing of the patient, status of dental development, functional patterns, timing and nature of maxillomandibular growth, patient cooperation, and parental interest. In essence, Class III treatment is directed toward:

**Mandible** > Control the vertical dimension (avoid bite opening) and reduce reverse overjet.

- Properly align lower incisors - avoid excessive proclination that complicates anterior coupling.
- Correct irregularities due to crowding (extraction vs. expansion?).
- Minimize mesial movement of lower buccal teeth (hold E-space? >> Lingual holding arches common).
- Correct segment relationships of lower buccal teeth (distalize > extractions?).
- Stop or redirect “Growth” of the mandible.

**Maxilla** > Expansion of transverse width and anterior protraction to allow proper overjet arch coordination.

- Advance the maxillary anteriors without extreme proclination to achieve overjet.
- Properly align upper incisors to couple lowers for anterior guidance.
- Correct irregularities due to crowding (extraction vs. expansion?).
- Correct segment relationships of upper buccal teeth.
  >> Mesialize bicuspids, and canines.
  >> Mesial movement of molars (Extract upper bicuspids? >> Extremely rare unless notable crowding).
- “Enhance “ growth of the maxilla through dentoskeletal protraction.

**CLASS III NON-EXTRACTION TREATMENT MODALITIES**

1. **Extraoral Reverse-Pull Headgear / Growth Modification**
   - “Redirects” or enhances maxillary growth with forward protraction.
   - Affects exerted on teeth or orthopedics depend on force application (direction, magnitude, duration, time, anchorage, patient age). Provides anchorage support for anterior protraction.
   - Allows transitional dentition treatment. Best results during incisor transition.
   - Expansion and occlusion changes may reduce forward mandibular positioning, abnormal function.
   - May restrain mandibular development.

2. **Maxillary Expansion**
   - All Class III malocclusions must be assessed for maxillary expansion, generally required to allow for maxillary advancement and coordination with mandible.
   - Orthopedic “sutural” expansion of bony base emphasized over orthodontic expansion, so age and biomechanics critical in maximizing orthopedic response.

3. **Interarch Elastics**
   - Creates anteroposterior and vertical forces.
   - Requires extensive anchorage support to avoid excessive upper molar and lower anterior extrusion.
   - Not indicated in patients who cannot tolerate rotation of the mandible, bite opening.
SKELETAL CLASS III @ age 5 to 12 years (mixed dentition)

- Retrusive Maxilla
  - Skeletally expand with rapid palatal expansion (Hyrax).
  - Advance or protract with reverse-pull facemask from Hyrax base.
  - Hold lower E-space with LHA to allow maximal lower anterior dental retraction.

- Protrusive mandible - Restraint of mandibular growth not documented long-term (e.g. chin cups), may redirect growth more vertically - usually contraindicated given dolichocephalofacial patterns. Approach as if the maxilla is retrusive (use facemask).

SKELETAL CLASS III @ age 12 to 15 years (adolescent)

- Mild to moderate mandibular prognathia, retrusive maxilla, adolescent – O.K. profile
  - Skeletally expand with rapid palatal expansion (Hyrax).
  - Advance maxillary incisors as much as tolerable with Edgewise advancement (e.g, NiTi stopped AWS), protract with reverse-pull facemask from AW base.
  - Mesofacial to brachyfacial growth ⇒ Class III elastics
    ⇒ Camouflage, lower 4–4 extraction

- Notable true mandibular prognathia, maxilla retrognathia, adolescent – Prognathic profile
  Restraint of mandibular growth and protraction of maxilla in permanent dentition not documented, may redirect growth vertically - contraindicated. Approach as if the maxilla is retrusive to the mandible (i.e. utilize reverse-pull facemask) to protract dentition or plan orthognathic surgery.

Reverse-Pull Headgear (Facemask) - To enhance anteroposterior forward and vertical development of maxilla along with protraction of maxillary dentition. Some possible redirection of mandibular growth.

- Hyrax anchorage to first permanent molars and second primary molars in early mixed transitional dentition, Quad-helix or Hyrax from second primary molars in primary dentition.
- Buccal engagement arm from molar bands extended forward to level of primary canines in both primary and mixed dentition patients. More anterior hook-up enhances vertical control – less posterior rotation.
- Expand maxilla for two to three weeks, then initiate reverse-pull forces.
- Force levels of 6 to 8 ounces per side initially, advance up to 12 to 16 ounces per side if necessary.
- Wear 12 to 14 hours per day (“in the house, in the mouth” – at home (bed, TV, homework).
- Usually about six to twelve months of cooperative wear. Target objective is end-on Class II.
- Retention using lighter elastics, 4 to 6 ounces sometimes necessary for one-year. May convert base appliance from expander to soldered palatal appliance with incisor contact.

Results from reverse-pull headgear wear attributed to:

- Mesial movement of maxillary molars / incisors > 1 to3 mm. forward movement over a year of wear.
- Produces “shearing” effect at sutures to maximize displacement of the maxillofacial complex - about 0.5 to 1.0 mm. forward movement of A-point in one year of wear.
- Enhanced downward and forward growth of maxillary complex.
- Decreased mandibular growth not specifically noted; often redirected vertically with increased lower face height. FMA increased, pogonion down & back as bite opens to enhance appearance of A-P correction.
- Increases lingual up-righting of lower incisors.

<table>
<thead>
<tr>
<th>Maxillary Orthopedic Protraction</th>
<th>0.5 to 2.0 mm.</th>
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<tbody>
<tr>
<td>Maxillary Dental Protraction</td>
<td>1.0 to 3.0 mm.</td>
</tr>
<tr>
<td>Mandibular Dental Retraction</td>
<td>? (Leeway)</td>
</tr>
<tr>
<td>Decreased Mandibular Growth</td>
<td>Redirected vertically</td>
</tr>
<tr>
<td>Total A-P</td>
<td>2.0 to 5.0 mm.</td>
</tr>
</tbody>
</table>
CLASS II & CLASS III TREATMENT MODALITIES & STRATEGIES: EXTRACTION OPTIONS

Extraction modalities to help “camouflage” an A-P skeletal discrepancy extends beyond the usual tooth size crowding issues and vertical growth patterns into sagittal plane compensations to achieve occlusion objectives. Growth modification may have been attempted and not fully successful; but enhanced facial patterns to allow extraction options to camouflage the Class II or Class III discrepancy. Presenting different scenarios and biomechanical challenges, the general concepts of extraction protocols regardless of Class II or Class III discrepancy are similar. These common considerations include:

- Mild to moderate bony discrepancy, non- to minimal growth potential remaining.
- Strive to achieve correct Class I canines, normal overbite & overjet with coupled incisors.
- Limitations in use with regard to facial cosmetic change, must monitor closely to not compromise.
- Require complex biomechanical control and relative anchorage to achieve quality results consistently.

Class II Skeletal & Dental Discrepancy ➔ Extraction “Camouflage” Indications & Modalities

- Moderate crowding or protrusion of the dentition; half to full Class II molar patterns.
- Acceptable facial esthetics not compromised by incisor retraction. Most favorable with:
  - ... increased nasolabial angle ... protruded incisors ... dolichofacial tendency
  - Over-retraction of upper anteriors and bite deepening may be associated with functional problems.
  ⚫ Maxillary 4 - 4 only ⇒ Good lower arch, maintains lower forward projection. Retract upper anteriors to Class I canines & normative overjet, Class II molars.
  ⚫ All four first bicuspids ⇒ Upper & lower crowding and/or protrusion. Should result in targeted Class I molars and canines by careful anchorage control.
  ⚫ Other extraction options available; used much less frequently.
    ⚫ Maxillary 4 - 4, mandibular 5 - 5 ⇒ Helps maintain lower proclination, poor molar contact likely result.
    ⚫ Maxillary first bicuspids, mandibular incisor (reduces lower anterior crowding).
    ⚫ Maxillary second molars >> To allow upper first molar distalization – plan long-term 3rd molar use.

Class III Skeletal & Dental Discrepancy ➔ Extraction “Camouflage” Indications & Modalities

- Moderate to severe crowding of the dentition.
- Acceptable facial esthetics not compromised by incisor mechanics to achieve anterior coupling -
  - Overall protruded maxillary incisors Overall retruded mandibular incisors
  - Lower molar anchorage may be necessary to optimize anterior retraction.
  - Over-retraction of lower anteriors may be associated with periodontal problems.
  ⚫ All four first bicuspids ⇒ Upper crowding, lower crowding or lower protrusion – goal Class I buccal.
  ⚫ Mandibular first bicuspids ⇒ Retraction of lower anteriors to Class I canines with normal overjet, stabilize Class III molars.
  ⚫ Other extraction options available; used less frequently include:
    ⚫ Maxillary second bicuspids, mandibular first bicuspids – to optimize upper anterior anchorage.
    ⚫ Mandibular incisor (lower anterior crowding, reduce proclination).
    ⚫ Asymmetric patterns

Class II / Class III Orthognathic Surgery - Extraction patterns may be necessary for relief of excessive dental arch crowding or excessive protrusion in preparation for orthognathic surgical options. These may need modifications in selected extraction options depending on location and severity of crowding, as well as the orthognathic surgical plan. Improper extractions may compromise the surgical planning.
DEALING WITH CONGIDENTALLY MISSING PERMANENT TEETH?

Key question - Should space be held or opened with plan to maintain primary tooth or fill space with prosthetics (bridge, implant) vs. closing space with adjacent tooth positioning?

Key answer – involves considerations as to consequences and effects on the long-term esthetic alignment of the dentition, proper functional occlusion, and facial esthetics.

Maxillary Lateral Incisors

Management decision is dependent on factors such as malocclusion findings (e.g. crowding, overjet), facial type, eruption patterns of permanent canines and central incisors, and status of the contralateral incisor. Note that congenitally missing upper lateral incisors are most often associated with a contralateral “pegged” lateral incisor if that lateral incisor is not also missing. Secondly, pegged laterals and missing laterals are associated with mesially displaced / impacted permanent canines.

1. Maintain primary lateral or manage space orthodontically with long-term plan for implant or bridge. Usual emphasis in non-crowded arches with Class I & Class III patterns to optimize anterior coupling. Literature suggests esthetics most appreciated by patients & clinicians with this approach.

2. Enhance movement of permanent canines forward into lateral position with extraction of primary laterals once the canine development reaches 2/3rds root formation. Concurrently save the primary canines in place. Later alignment using Edgewise appliances is expected for “canine replacement”. Usual emphasis with crowded arches and in Class II patterns to allow reduction in overjet discrepancy and elimination of prosthetics - this appreciated at least in short term by parents and patients.

Mandibular Second Premolars

1. Maintain second primary molar or hold the space with long-term plan for using the primary molar as long as possible and/or fill the space with implants or bridge. Usual emphasis in non-crowded arches with Class I & Class II occlusion patterns to maintain proper lower arch support and anterior coupling. Note - this became greater option with development of bonded bridges in 70's and implants in 90's.

2. Enhance forward movement of permanent first molars with early extraction of primary molar in conjunction with molar eruption. Later alignment using Edgewise appliances for full space closure is anticipated. This is more likely the emphasis in crowded arches and with Class III occlusion patterns. Note- Advent of temporary anchorage devises (TADS) has greatly influenced this option in terms of planning. This consideration applies to cases that traditionally fell into the option #1 category.

With ankylosis of primary molar, may choose to monitor if ankylosis occurs late and does not affect occlusal relationships dramatically. Width and vertical relations may be maintained with composite build-ups and/or stainless steel crowns. The eventual treatment may still involve later extraction of the primary molar if alignment is problematic. Replacement with implants or a bridge remain as options.

If ankylosis occurs early in dentitional development, particularly in the maxillary arch; early extraction is suggested to enhance occlusal outcomes by avoiding vertical displacement of opposing teeth and collapse of the arch. Secondarily, later extraction is much more complicated as to surgical access and loss of cortical bone during the surgery. Appropriate space maintainers may be placed in the mixed dentition to hold the space in terms of option #1 unless the A-P discrepancy or associated crowding justifies space closure as related to option #2. Note again that TADS influence this option in terms of long-term planning for cases that traditionally fell into the option #1 category.
BIOMECHANICS OF “AGE_APPROPRIATE” ORTHODONTIC TREATMENT: APPLIANCES

Orthodontic treatment interventions may be directed toward anteroposterior adjustments in arch length, transverse expansions of arch width, vertical control of eruptive movements, and/or maxillary-mandibular orthopedic modifications in growth direction and magnitude. The indications for various treatment possibilities, biomechanics for the procedures, prognosis for successful change, and stability factors associated with each treatment mode are varied, multi-factorial, and frequently contradictory. The clinician must recognize that every appliance has potential secondary effects both positive and negative to orthodontic-orthopedic outcomes. The suggested appliances have been chosen because they have produced the most consistent and desired effects while also fitting into a philosophical approach to appliance management. This includes a short list of “rules” that considers appliance design, cooperation, and practice management in the context of efficiency and effectiveness of therapy. The rules in appliance use are grounded in modalities that are simple in concept and application - the **KISS rule**. This suggests appliances that:

1.) Require fewer and easier adjustments and/or appliance changes;
2.) Necessitate shorter and less frequent appointments;
3.) Are associated with less discomfort,
4.) Present minimal detrimental effects to hard and soft tissues;
5.) Maintain maximum control of tooth movements through directed forces;
6.) Are stable and durable;
7.) Are reasonably accepted and understood by the patient and parents.

Orthodontic treatment is accomplished through the coordinated use of **Priority Appliances** (i.e. common or more routine usage) with **Supplemental Techniques** (i.e. special or less common usage). The coordination of appliances provides the clinician a varied armamentarium necessary to meet the demands presented by different malocclusion factors. A multifaceted armamentarium is essential to quality results - under no circumstances should treatment plans be dictated by the clinician’s lack of versatility or flexibility; rather the treatment needs should direct the choice of technique. One deviation from this concept of flexibility is that by and large, fixed appliances meet the overall criteria in a controlled and predictable manner more often than do removable appliances. Priority and supplemental appliances are categorized by their primary mode of action in terms of anteroposterior adjustments in arch length, transverse arch expansion, vertical control of eruptive patterns, and skeletal influences.

**Priority Appliances** commonly advocated for orthodontic biomechanical treatment include:

**Maxillary Arch Development**

1.) Twin Edgewise appliances (2 X 4 mixed dentition set-up, full band & bond permanent) *
2.) Fixed-removable transpalatal arches (Goshgarian Appliance)
3.) Cervical or high-pull headgear
4.) Quad-helix appliance (primary and mixed dentition arch expansion)
5.) Banded Hyrax (mixed to adolescent dentition palatal expansion)

**Mandibular Arch Development**

1.) Twin Edgewise appliances (2 X 4 mixed dentition set-up, full band & bond permanent) *
2.) Lingual Holding Arch
3.) Lip Bumper (late mixed dentition)

* Twin-Edgewise straight-wire prescription (Bioprogressive High-torque), 0.022 slot.
**Supplemental Appliances**

1.) Halterman Appliance - for ectopically trapped molars.
2.) Palatal Crib Appliance - for thumb-sucking habits.
3.) Fixed Maxillary Lingual Arch with finger-springs for anterior crossbites.
4.) Space Maintainers - Lingual holding arch, Nance appliance, soldered Transpalatal, Band or Crown and Arm, Distal Shoe, Maxillary Hawley.
5.) Removable Hawley Appliances (with active components):
   a) Lingual finger- or sweep-springs for anterior flaring.
   b) Palatal jackscrews oriented for A-P dental movement (i.e. Sagittal Appliance) or transverse dental expansion (i.e. Schwartz plate).
   c) Labial elastics for incisor retraction.
6.) Bihelix Appliance - for lower dental expansion.
7.) E-Arch - for upper expansion (same as facebow expansion)
8.) Reverse-pull Facemask
   a) Heavy, intermittent forces for maxillary / dental protraction (primary to early mixed dentition) in conjunction with maxillary expansion appliances, usually Hyrax.
   b) Light, continuous forces for dental protraction (late mixed).
9.) Functional Appliances - Class II Dentofacial Orthopedics
   a) Activator / HPHG Combination: Dolichofacial Openbite tendency
   b) Orthopedic Corrector: Meso- to Brachyfacial Deepbite tendency
   c) Herbst Appliance: Adolescent permanent dentition, Meso- to Brachyfacial growth pattern.

**Final Retention & Observation Phase Retention Appliances:**

- Sectional wire to incisors or canines - Lingual fixed bonded retainer.
- Transpalatal Bar or Nance appliance – Leeway space management, hold molar corrections.
- Lower Lingual Holding Arch
  - Hold alignment of lower incisors after Phase I 2X4 alignment (spur distal to laterals).
  - Leeway / E-space management.
- Night time HG to hold Class II correction in mixed dentition.
- Night time Facemask to hold Class III correction in mixed dentition.
The use of wide standard (medium width) Twin-Wing Brackets enhances rotational control and mesiodistal angulation (tip) of the engaged teeth through incorporation of straight-wire concepts in leveling and alignment. With the advent of super-flexible, low-load, high deflection titanium archwires for initial bracket engagement; significant interbracket distance is not required to fully engage the bracket and express the archwire memory. The siamese-twin Edgewise brackets also allow for efficient and effective engagement of elastomeric chains and ligature ties for controlled siding mechanics on stiff and rigid archwires.
# EDGEWISE TREATMENT VARIABLES AND CONTROL

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>CONTROL FACTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arch Leveling / Alignment</td>
<td>Archwires in Progression</td>
</tr>
<tr>
<td>Initial</td>
<td>.014 or .016 NiTi</td>
</tr>
<tr>
<td>Secondary</td>
<td>.020 NiTi</td>
</tr>
<tr>
<td></td>
<td>.019 X .025 NiTi – If early torque or AW expansion needed</td>
</tr>
<tr>
<td>Working</td>
<td>.020 S.S. - Sliding Mechanics</td>
</tr>
<tr>
<td></td>
<td>.019 X .025 TMA - Torque &amp; arch expansion</td>
</tr>
<tr>
<td>Anchorage</td>
<td>.019 X .025 S.S.</td>
</tr>
<tr>
<td>Finishing</td>
<td>Segmented AW’s / Elastics</td>
</tr>
<tr>
<td>1st, 2nd, 3rd Order Adjustments</td>
<td>Pre-adjusted SWA Appliance supplemented by:</td>
</tr>
<tr>
<td></td>
<td>Band &amp; Bracket positioning</td>
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<tr>
<td></td>
<td>Archwire Choices – Round versus rectangular, material</td>
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<tr>
<td></td>
<td>Detailed archwire bends</td>
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<tr>
<td>Cuspid Retraction</td>
<td>Sliding Mechanics (on .020 S.S. or reduced 19 X 25 S.S.)</td>
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<tr>
<td></td>
<td>Selected Elastomeric Chains (6 &lt;&lt;&lt;&lt;&lt; 3 )</td>
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<tr>
<td></td>
<td>Open-coil Springs 3 &lt; 3 (Incisors by-passed)</td>
</tr>
<tr>
<td>Incisor Retraction</td>
<td>Incisors Moved En Masse (as a consolidated group)</td>
</tr>
<tr>
<td>Proclined</td>
<td>.020 S.S. Begg-loops / elastomeric chain</td>
</tr>
<tr>
<td>Normal Inclinations</td>
<td>.019 X .025 TMA / Closing loops</td>
</tr>
<tr>
<td>Retroclined</td>
<td>.019 X .025 TMA Utility Arch supported by 19 X 25 S.S.</td>
</tr>
<tr>
<td>Anchorage</td>
<td>Class II / III elastics -1/4 in.,4 to 6 ou., reduce 19 X 25 S.S.</td>
</tr>
<tr>
<td>Incisor Protraction</td>
<td>Incisors Advanced En Masse (as a consolidated group)</td>
</tr>
<tr>
<td>Retroclined</td>
<td>Stopped .016 / .020 NiTi AWs in Sequence (Guren locks)</td>
</tr>
<tr>
<td></td>
<td>Opening AW omega loops</td>
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<tr>
<td>Space Opening</td>
<td>Sliding Mechanics (on .020 S.S. or reduced 19 X 25 S.S.)</td>
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<tr>
<td></td>
<td>NiTi open-coil springs or reciprocal elastic chains</td>
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<tr>
<td>Anchorage</td>
<td>Molar Control With:</td>
</tr>
<tr>
<td>Maxillary</td>
<td>TPB – Removable (Goshgarian) or Soldered</td>
</tr>
<tr>
<td></td>
<td>Directed Headgear – Cervical or High-pull</td>
</tr>
<tr>
<td></td>
<td>Quad-helix, Hyrax (soldered 4-point)</td>
</tr>
<tr>
<td>Mandibular</td>
<td>Lingual Holding Arch (soldered)</td>
</tr>
<tr>
<td></td>
<td>Lip Bumper (Removable or soldered)</td>
</tr>
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