Goals: This series of lectures should enable the resident to:
1. Understand how growth modification in the growing child, and orthognathic surgery in the adult, represent the end components of maxillofacial orthopedics.
2. Recognize the potential and limitations of both modalities.
3. Understand hazards related to orthognathic surgery.

Objectives: The resident should know:
1. The basic concepts underpinning growth modification and orthognathic surgery.
2. The orthognathic process:
   a- the importance of tooth inclination relative of bone in this process of normalization among teeth and jaws;
   b- the application of this principle in growth modification and orthognathic surgery;
   c- the key role of the orthodontist in this process.
3. The scope of constitutional limitation relating to the fact that the nature of a dysmorphology is self-limiting, particularly when it is not confined to one facial feature.
4. That orthognathic surgery, although the favored treatment for many skeleto-dental dysplasias, may not yield an ideal result because of both constitutional and/or therapeutic limitations.
5. That the potential of growth modification in a child should not be discarded on the account of greater bone movement possible with orthognathic surgery at a later adult age. The level of change also depends on the site of change (mandible, chin, lips, …). Decisions are best made on where scientific evidence is available.
6. Specific hazards encountered with orthognathic surgery, associated with surgery proper, or side effects (periodontal complications, relapse, root resorption).
weekly basis for at least 3 sessions. Preferred precursors to this course are those related to early treatment and orthognathic surgery.

POLICY ON EXAMINATIONS: At least 2 biannual examinations (progress and final) are given for all courses, if a course spans the entire year. If classes terminate before the end of a semester, the final examination is given at the semi-annual examination that is closest to the end of the course, unless the course director schedules the final examination earlier. During a course, any number of progress tests or assignments may be given. Their cumulative weight in proportion to the final grade may not exceed 50%.

GROWTH MODIFICATION VERSUS ORTHOGNATHIC SURGERY

SUMMARY OUTLINE

1. DIFFERENT POTENTIALS FOR GM AND OS

LIMITATIONS OF GM AND ORTHODONTICS WITH OS

- Constitutional limitations
- Therapeutic limitations

AND LIMITATIONS of treatment combining orthodontics and orthognathic surgery

COURSE OUTLINE

1. POTENTIAL AND LIMITATIONS OF GROWTH MODIFICATION AND ORTHOGNATHIC SURGERY

Introduction

Questions are asked and answers are presented that emerge from the evaluation of research and clinical observations:

1- Is the hand of growth in early treatment equal to the hand of the orthognathic surgeon in the adult. Growth modification may forego the need for surgery under certain conditions. Timing and duration of treatment are critical.

2- What are the limitations of growth modification and treatment combining orthodontics and orthognathic surgery?

A- Constitutional limitations that stem from the nature of the dysmorphology, soft tissue anatomy and adaptation, and the direction and amount of bone and tooth movement. The limitations may be related to improper or compromised treatment planning, as well as side effects of surgery and tooth movement.

Clinical reports, literature review, and pilot research data, help to emphasize the importance of facial esthetics. Treatment should not be planned based on the skeletal relationships only. Limitations could be minimized in view of available data, in favor of expansion rather than constriction of the facial soft tissue mask.

Although orthognathic surgery aims at improving masticatory function and possibly speech, it offers an opportunity to improve esthetics that should not be missed.
B- Therapeutic limitations, which may be related to improper or compromised treatment planning, direction and amount of tooth movement (dentoalveolar normalization or decompensation) and bone displacement, as well as side effects of surgery and tooth movement. The lecture series emphasizes ways to minimize limitations in view of available scientific data.

1- POTENTIAL OF GROWTH MODIFICATION AND ORTHOGNATHIC SURGERY

A- Basic Concepts
Similarities in goals regarding amount and direction of bone movement

Growth modification:
Through (orthopedic) forces:
- Change in the absolute size of a jaw
- Redirection of growth
- Differential growth between jaws

Orthognathic surgery:
Through surgery
- Change in the absolute size of a jaw
- Redirection of position
- Differential positioning of jaws

B- Growth modification of the maxilla
Growth modification of the maxilla involves procedures that affect maxillary deficiency or excess in all planes of space: maxillary size reduction (headgear), expansion (palatal distraction), or position (retraction or protraction).

-Potential for growth modification depends not only on the patient’s age, but also constitutional characteristics of the maxillary complex and its relation to the mandible.

-Data analysis from research and clinical sources:
1- a longitudinal study of head gear used for 2 years to correct Class II, division 1 malocclusion in prepubertal children (n=36);
2- a cross-sectional study of palatal expansion (n=24);
3- reports of successful treatment of anterior crossbite and Class III malocclusion with a facial mask.

-Results indicate that maxillary growth modification limited by
1- factors within the maxilla itself (e.g. maturation of sutures; non-concordance of centers of resistance of maxillary bone and dental components);
2- its relation to the mandible (mandibular size dictating maxillary treatment or causing maxillary retrognathism unless the anterior crossbite is treated early);
3- function (e.g. mouth breathing).
C- Growth modification of the mandible
-recognized mostly in the treatment of Class II, division 1 malocclusion.
-severe limitations for
  *restriction of mandibular growth in Class III malocclusion;
  *mandibular constriction or widening in mandibular transverse problems.
-Controversies on effect of growth modification (functional appliance) regarding
  mandibular forward growth stimulation or enhancement. Tested possibilities:
  1. mandible surpasses its growth potential- NO conclusive evidence.
  2. mandibular growth is accelerated- Difficult to gauge clinically, although demonstrated
     in animals.

These hypotheses assume that the individual growth potential can be predicted within
reasonable accuracy.
  3. mandible is merely positioned forward and subsequent growth, if sufficient, adapts
     (“catches up”) to this position. This hypothesis assumes that
     (a) occlusal interdigitation plays an important role in maintaining the mandible in
     the forward position;
     (b) the most important effect of a functional appliance is the distal force on the
     maxillary complex. Effect is achieved through forces transferred to maxillary teeth
     and bone by the appliance

D- The orthopedic process
-Natural compensation for skeletal disproportion between jaws with dentoalveolar
  inclinations toward a functional occlusion: in Class II malocclusion, maxillary anterior
  teeth compensate by retroclining, mandibular incisors by proclination.

  1- surgery without orthodontics: minimal amount of movement obtained.
  2- ideally, prior to surgery, orthodontic optimal positioning of teeth over basal bone:
     dentoalveolar normalization or decompensation.
  3- Conceptually, as relates to position of the incisors, growth modification and
     orthognathic surgery are different facets of the same coin.

Dentoalveolar normalization, can actually be summed up by getting the teeth out of the
way of the surgeon- or growth- to allow for optimal movement of the bones.

Working guideline in sagittal plane: achieve at the end of presurgical orthodontic process
(or growth process) canine occlusion in Class 1, and optimal incisal overjet (inclination
of maxillary incisors can limit or require modification of surgical movement –or needed
amount of growth-, particularly when maxillary or mandibular rotation is part of surgery).

2- LIMITATIONS OF GROWTH MODIFICATION AND ORTHOGNATHIC SURGERY
In contrast to growth modification, orthognathic surgery can improve the shape of the
chin through genioplasty, but with both modalities, it is difficult to manage the nasolabial
relationship when the nose is tipped upward.
Factors that limit the achievement of optimal esthetics in maxillofacial orthopedics (growth modification in growing children, and orthognathic surgery in adults) were evaluated. Findings suggest that the nature of the dysmorphology is self-limiting from therapeutic and esthetic perspectives.

2a- Constitution of patient
1- Nature of dysmorphology
2- Soft tissue evaluation and adaptation

2b- Treatment
1- Treatment planning
2- Direction and amount of bone and tooth movement
3- Duration of treatment or surgery
4- Stability of results and implications
5- Side effects of tooth movement and surgery

A- Limitations of growth modification
If growth modification is started early enough, do we get enough expression of differential growth to mirror results of orthognathic surgery?
- Research data not available
- Issue of practicality and length of treatment
- WIDE INDIVIDUAL VARIATION
- Incisor inclination: Issue of compensation/decompensation and impact on jaw position

B- Limitations of orthognathic surgery
Limitations of orthognathic treatment are also related to the patient’s constitution or to actual therapeutic limitations.

- Treatment limitations associated with treatment planning; direction and amount of bone and tooth movement; duration of surgery; stability of results and implications; and side effects of surgery and tooth movement.
- Critical limitations relate to dentoalveolar normalization: position and inclination of maxillary incisors can limit or require modification of surgical movement, particularly when maxillary rotation is planned.
- Prediction of outcome is also limiting.

B1- Prediction of soft tissue changes following orthodontics and orthognathic surgery
- wide variation on accuracy of prediction
- limitations related to: variability of conditions in the study of treatment outcome; variability in surgery (e.g. procedure, extent of movement [over or under treatment], method of wound closure); variability in anatomy and adaptive potential of soft tissue; interaction in different planes of space (2D vs. 3D) and between different structures; factors of tooth movement and growth. However, trends can be described about overall facial changes and specific features:

B1a- General trends
1- Horizontal changes more predictable than vertical changes, which vary considerably.
   -vertical changes smaller in nature, or
   -vertical hard tissue changes less predictable and less stable than horizontal movements.
2- Soft tissue response depends on the type of surgical procedure.

B1b- Specific facial features
1- Nose: degree of control of nasal changes factor of amount and direction of surgical movement of the maxilla. Predictability of the response is limited.

2- Upper lip:
   - vermillion border cannot be increased with orthognathic surgery (may need adjunctive cosmetic surgery);
   - lengthening cannot be achieved with orthognathic surgery (unpredictable success through cosmetic procedures);
   - response to vertical movement maxilla fully predictable (considerable variability).
     *In response to down movement, upper lip does not shorten; therefore, the amount of bony movement that is needed must be achieved, and should not be undercorrected.
     *Similar rationale applies to maxillary impaction, which also should not be undercorrected.
   - response to forward movement: does not follow in a 1:1 ratio. Reasons: possible stretching of lip or incision of the lip.

3- Lower lip: most variable of soft tissue landmarks in response to orthognathic movement.

4- Chin:
   -mandibular advancement: the least variable (generally 1:1 ratio).
   -mandibular set back: a submental fold may occur leading to double chin appearance that would require submental lipectomy.
   -genioplasty: remarkable to improve esthetics; should not be overdone. Moving chin back is least predictable genioplasty because soft tissue displaces at a ratio of less than 0.5 to 1.

*Limitations in soft tissue response to movement of underlying hard tissues lead to the consideration of adjunctive cosmetic procedures (e.g. rhinoplasty, cheiloplasty, liposection) to improve facial esthetics.*

**Comparative limitation of treatment between growth modification and surgery (orthognathic and cosmetic)**

<table>
<thead>
<tr>
<th>Facial feature</th>
<th>Limitation of Treatment</th>
<th>Site of correction</th>
<th>Potential of correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forehead</td>
<td>GM, S</td>
<td>B/ST</td>
<td>Surgery (P)</td>
</tr>
<tr>
<td>Nose tip</td>
<td>GM &gt; S</td>
<td>C/ST</td>
<td>Surgery (P)</td>
</tr>
<tr>
<td></td>
<td>GM, S</td>
<td>ST</td>
<td>Surgery??</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------</td>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Length of upper lip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness of upper lip</td>
<td>GM, S</td>
<td>ST</td>
<td>Surgery (P)</td>
</tr>
<tr>
<td>Thickness of lower lip</td>
<td>GM, S</td>
<td>ST</td>
<td>Surgery (P)</td>
</tr>
<tr>
<td>Chin (shape of)</td>
<td>GM &gt; S</td>
<td>B/ST</td>
<td>Surgery (S, P)</td>
</tr>
</tbody>
</table>

GM- growth modification  S- orthognathic surgery  P- plastic surgery  
B- bone  C- cartilage  ST- soft tissue

2. HAZARDS AND LIMITATIONS OF TREATMENT COMBINING ORTHODONTICS AND ORTHOGNATHIC SURGERY

1- IMPROPER PLANNING*

A- Surgery versus orthodontics  
   - orthodontics without surgery  
   - surgery without orthodontics

B- Dentoalveolar compensation  
   over, under (limited)

C- Surgery  
   - Amount of movement (Optimal/Compromised)  
     (expansion, advancement, setback, impaction, extrusion)  
   - Asymmetry
D- Growth
  additional growth: amount, duration

E- Soft tissue
  thickness and response

2- SIDE EFFECTS/COMPLICATIONS

A- Surgery
  -surgical technique (healing, complications)
  -altered position of mandible

B- Root resorption

C- Periodontal complications

D- Relapse

REFERENCES

PART 1

PART 2


ADDITIONAL REFERENCES