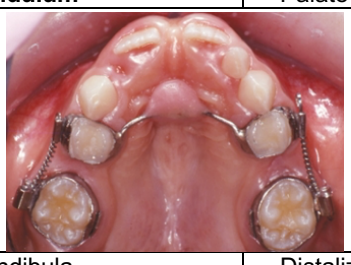
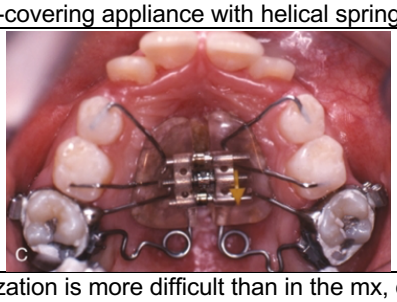
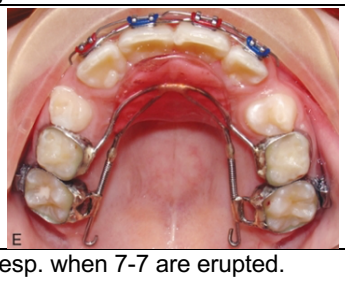
Expansion for tx of crowding in the early or late mixed dentition

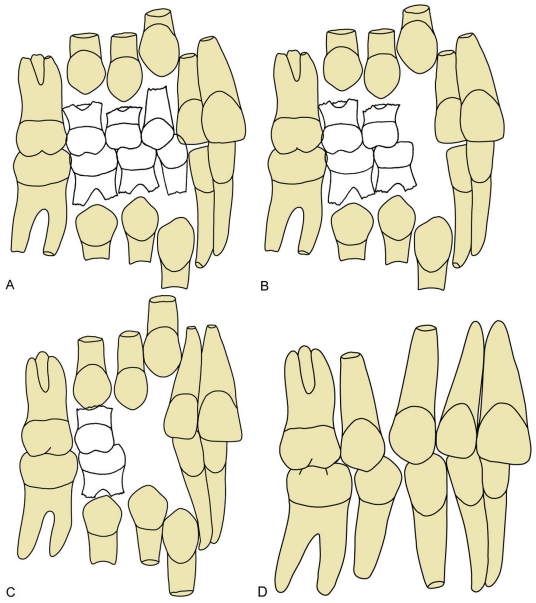
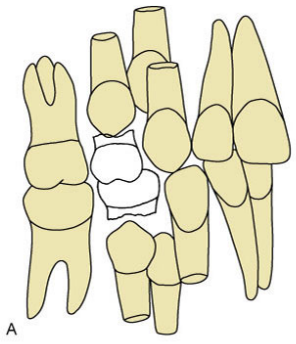
Indication	• Lower incisor position is normal or somewhat retrusive • Lips are normal or retrusive • OJ is adequate • OB is not excessive • Good keratinized tissue facial to the lower incisors - The indication for a prior gingival graft should be evaluated. → There is mixed evidence regarding the usefulness of pre-tx and post-tx gingival grafting. - Lack of data to document the effectiveness of early arch expansion to prevent later crowding in the permanent dentition. → The ability of expansion in the primary dentition to meet the challenge of anterior crowding is highly questionable and unsubstantiated. - No long-term data available to support the claim that early expansion improves the occlusal relationship in cl.II patients. - Unlikely that the soft tissue, which establishes the limits for arch expansion, reacts differently to transverse expansion at different ages.
Types of expansion	• Mx dental or skeletal expansion: Moving the teeth facially or opening the midpalatal suture. • Mn buccal segment expansion by facial movement of the teeth. • Advancement of the incisors and distal movement of the posterior teeth.
Appliances	- Ex of III±III and lingual arch to allow the incisors to align themselves. (rotations will not correct) - Lingual arch or other appliances to increase the arch length. - Fixed appliance 2:4 with coil springs to tip the lower incisors facially. - Transverse expansion of the upper arch: • Lingual arch • Jackscrew expander: Use slowly and carefully in the mixed dentition!

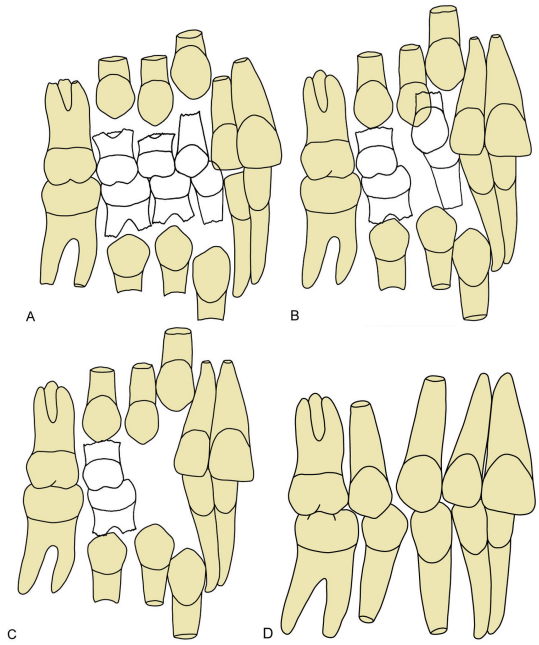
Expansion for crowding in the late mixed dentition: Molar distalization

- Cave: Facial incisor movement as side effect for distal molar movement with an intraoral appliance.

- Indications:
  - < 4-5 mm space required per side by predominantly tipping.
  - Erupted maxillary anterior teeth and ideally first premolars for anchorage.
  - Lips and maxillary dental protrusion should be normal or retrusive, because about $^1/_3$ of the movement will be experienced as facial incisor movement.
  - Limited OJ.
  - Vertical facial dimension normal or short-face tendency.
  - OB somewhat greater than normal.

HG	- The force should be as constant as possible. - Moderate force because it is concentrated against only two teeth: 400 gm / side. - *Reitan*: Transition orthodontic / orthopedic force at **~400 gm**. - *Bowden 1978*: Ideal force for headgear: ○ **200-300 g** without 7+7 ○ **400 g** with 7+7 ○ **>400 g** orthopdedic effect - Minimum wear time 12-14 h. - 1 mm / month distalizationmovement.
Pendulum	- Palate-covering appliance with helical springs.
  	
Mandibula	- Distalization is more difficult than in the mx, esp. when 7-7 are erupted. - Eruption of 7+7 makes distalization of 6-6 even more difficult. → Fixed appliance = often the best approach.

Early (serial) extraction	
Indication	- Space deficiency > 10 mm and no skeletal problems. - Reduction of crowding and irregularity during the transition phase. - Allow the teeth to erupt over the alveolus and through keratinized tissue, rather than being displaced buccally or lingually. - Adjunct to later comprehensive tx, not a substitute for it (makes it easier & sometimes quicker) → serial extractions almost never result in ideal tooth position by itself.
Normal sequence of extractions	1. **II I ± I II**: Ex if necessary 2. **III ± III**: Ex to provide space for alignment of the incisors. → Cave: Usually some lingual tipping of the incisors and increased OB. 3. **IV ± IV**: Ex when ½ - $^{2}/_{3}$ of the root is formed: → Speed up the eruption of 4±4 before 3±3 erupt. 4. **4 ± 4**: Ex ater eruption → Canines erupt into the remaining extraction space. 5. **V ± V**: Should exfoliate normally. 6. Close the residual space by drifting and tipping of the posterior teeth unless a full appliance tx is implemented. - The premolar extraction spaces close partially by mesial drift of the 2nd premolars and permanent 1st molars, but mainly by distal eruption of the canines.  - Cave: Premature eruption of the 3±3: → 4±4 are impacted between the 53±35. → Surgical removal 4±4 is necessary. - Surgical removal of 4±4 is possible together with the extraction of IV±IV if it's obvious that the canines will erupt before the premolars. = **Enucleation**. Cave: Early enucleation can leave a persisting bone defect. 

Alternative extraction sequence approach	- Implemented slightly later, but under the same conditions: 1. IV ± IV: Ex. → Less lingual tipping of the incisors and less tendency to develop a deep bite compared to the extraction of primary canines or incisors. → To encourage early eruption of the first premolar. 2. III ± III: Normal exfoliation. 3. 4 ± 4: Ex after their eruption. Let 3±3 erupt into the remaining extraction space. 4. V ± V: Should exfoliate normally. 5. Close the residual space by drifting and tipping of the posterior teeth unless a full appliance tx is implemented. 
TADs	- No TADs < 12 y - Cave: • Surgery necessary. • Long duration of tx to move and retain the teeth from the mixed dentition until the eruption of the permanent teeth. - Uncertain stability of long-term results.
Borderline crowding cases	
- Keep the options open for late comprehensive tx which will be needed. - Maintaining the leeway space during the last part of the transition to the permanent dention increases the chance of successful nonextraction tx, if the space is adequate or borderline. - Early extraction of primary canines often can provide space for some spontaneous alignment of permanent incisors and decrease the chance of canine impaction. A lingual arch is needed to keep the non-ex option open.	

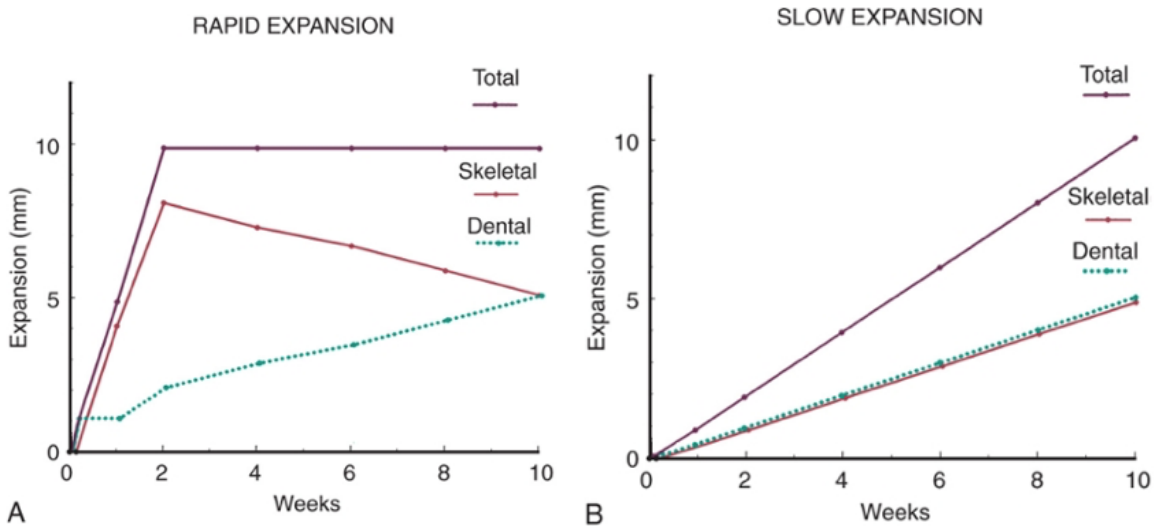
Proffit Chapter 13:

Growth Modification: Treatment of Skeletal Transverse and Cl.III Problems

Principles in timing of growth modification	
Timing in relation to the amount of remaining growth	- Correct a skeletal problem by more or less growth of one jaw than the other. - Force is applied to the teeth and secondary & indirectly to the skeletal structures. → Some tooth movement is unavoidable. - Different timetables for growth in the three planes. - Children's compliance is affected by the stage of maturation and the difficulty of doing what the doctor expects them to do: → Better compliance with a simple appliance. - Growth modification must be done at any point before the adolescent growth spurt ends. - 4-6 y: • Rapid growth rate, smaller and more plastic skeletal components. → Sign. amounts of skel. discrepancy can be overcome in a short time. • Idea that if the jaw relationships are corrected, proper function will cause harmonious growth thereafter without need for further tx. • Cave: o Relapse in the disproportional growth pattern. o 2nd phase of tx during adolescence necessary. o → Early tx for skeletal problems is restricted to the mixed dentition years. - Indication for early tx (exceptions): • Jaw discrepancy which impairs esthetics and results in social problems. • Dental and skeletal profile highly susceptible to trauma.
Different timing for different planes of space	- Transversal: • Growth stops first with the begin of midpalatal suture bridging. • Tx more physiologic when done prior to adolescence: → Later only possible with heavier forces. - Sagittal: • Mx protraction: o Before 11 y of age. o Later only effective with skeletal anchorage. • Changes until the late adolescence: → No urgency for early (preadolescent) tx for most malocclusions. - Vertical • Growth stops in the 3th decade. - Do timing according to the patient's tolerance, compliance, financial and behavioral situation.

Growth modification in the transverse plane of space	
- Maxillary width should be compared to other transverse proportions in the patient (nose, face…) and not to population averages. - Maxilla opens as if on a hinge, with its apex at the bridge of the nose and a hinge anterior-posterior separating anterior > posterior.	
Effect of transverse expansion	• Forward movement of the maxilla (as likely as backward movement). • Space increase in the arch. • Reposition of underlying permanent tooth buds as they move along with the bone. • Adequate expansion that coordinates the mx and mn arches, eliminates mn shifts and interferences.
Timing of palatal expansion	- Can be done at any time prior to the adolescent growth spurt, easier before the midpalatal suture is fused. - The midpalatal suture is more tortuous with increasing age: • <u>Preschool children:</u> Heavy force and rapid expansion contraindicated: → Risk to produce a flat nose at this young age. • <u>Age 9-10 y:</u> Almost any expansion devise separates the sutures and moves the teeth. • <u>Adolescents:</u> Heavy force from a rigid jackscrew device needed. Suture must be microfractured. RPE / SPE / bone screws. • <u>Adults:</u> Surgery to reduce the resistance.
Palatal expansion in the primary and early mixed dentition	- Less force needed to open the suture. → All appliances produce skeletal and dental changes. - <u>Removable appliance:</u> • Slow expansion indicated. • Faster expansion = higher force → Retention problems of the appliance. • Compliance needed. • Correction takes much time → not cost-effective. - <u>W-Arch/ QH:</u> • Clean and reasonable effective. • Can open the midpalatal suture in young patients. • Mix of skeletal $^1/_3$ and dental expansion $^2/_3$. • Preferred approach in young children. • Evidence that effectiveness ↑, patient's comfort ↑ and efficiency ↑ compared to removable appliances. (*Agostino, 2014*) - <u>Fixed jackscrew:</u> • Bulkier and more difficult to place and remove. • Cleaning problems, soft tissue irritations. • Activation by the parents. • Risk of distortion of the facial structures → Avoid in young children! • No evidence to produce better or more stable expansion. • No evidence of any advantage of rapid movement and high forces in children. → If used, then only careful and with slow activation. - 10 y after tx, rapid and slow palatal expansion - although sometimes used for different magnitudes of constriction - have found to be stable (*Filho, 2008*) - Petrén 2011: - Anteroposterior dental changes in terms of OJ are not consistently correlated with mx expansion: forward movement of the maxilla is as likely as backward movement.
Palatal expansion in preadolescents **(late mixed dentition)**	- Sutures are more tightly interdigitated: o → Heavier force directed at the suture needed, which microfractures the interdigitated bone spicules. o → Fixed Jackscrew appliance needed (banded or bonded). - Include as many teeth as possible in the anchorage. (advanced root resorptions of primary teeth)

	- Increase in vertical facial height possible (mostly transitory). o Older patients → less likely that vertical changes will be recovered by subsequent growth. o Patients with long-face tendency: → use a bonded appliance that covers the occlusal surface of the posterior teeth to produce less mn rotation. (long-term effect not clear). - Slow (< 2 mm/w) or rapid expansion possible. After 10-12 w: o Same ultimate results o BUT fewer traumas to the teeth and bone with slow expansion. o Same amount of dental and skelettal expansion. - Minimum 3 m retention with the appliance + afterwards TPA or heavy expanded mx buccal arch.
Palatal expansion in adolescents **(early permanent dentition)**	- Mid adolescence: Nearly 100% probability of opening the midpalatal suture with a banded or bonded expansion device. - Interdigitation of the suture ↑ when the growth spurt ends. - Judgment of the suture interdigitation: o Chronical age o Developmental age o CVMS (cervical vertebra maturation staging) (not validated) o 5-stage midpalatal suture density ratio **MSDR** (not validated): Calculation uses grey levels from CBCT images of defined palatal regions. → Only MSDR is sign. correlated with the potential of the desired expansion. - Expansion with skeletal anchorage is more likely to be successful. - RPE is indicated, because force is built-up to the point that the suture either fractures or the tx is discontinued. - SPE would be likely to move only the teeth and not open the suture.
Late adolescence	- Tooth-supported expansion should not be attempted. - Use micro-implant supported expansion with 0.25 mm activation per day to minimize disruption of the suture. - SARPE and segmental osteotomy of the mx in reserve.
Rapid expansion	1. **0.5-1 mm/day**. **10-20 pounds** pressure around the sutures (1p = 0.454 kg). 2. Initially 80% skeletal effect, 20% dental effect. Space in the suture is initially filled with tissue fluid and hemorrhage: → Highly unstable. 3. 3-4 m retention necessary until bone has filled the space. → Diastema ↓ → The stretched palatal tissue creates a lingual force against the molars and premolars → tooth movement allows the halves of the mx to move back towards each other even though the teeth remain separated. 4. Removable retainer often needed as further insurance against relapse. Alternatively, a TPA or heavy mx wire can be applied if further tx is accomplished immediately. - *Leonard, 2011*: Most of the movement is separation of the 2 halves of the mx, but force is also transmitted to adjacent posterior structures. - Cave: Tooth movement continues until bone stability is reached. Tooth movement allow the bony segments to reposition themselves, while the teeth stay in the same position. → RPE is no effective way to minimize tooth movement. - *Akkaya, 1998*: RPE = greater expansion regio canines compared to SPE. → Arch perimeter ↑, but similar opening of the suture. - Often a diastema appears because: o Suture opening anterior > posterior. (the suture opens like on a hinge) o Suture closure begins in the posterior area of the midpalatal suture. o Later diastema closure by skeletal relapse & tooth movement. (stretched gingival fibers)



Slow expansion	- **< 2 mm/w**. - **2 pounds** pressure in a child with mixed dentition. (1p = 0.454 kg) - Opening of the suture at a rate close to the mx bone formation. - Tissue damage and hemorrhage at the suture are minimized, - No diastema develops. - Skeletal and dental changes occur. o X-ray can show an opening of the suture. o The amount of skeletal and dental contribution to expansion after 10-12 w is similar for SPE and RPE. o SPE: Smaller expansion regio canines compared to RPE. - Don't replace the expansion appliance with a tooth supported retainer before 12 w retention. - No long-term differences between semirapid expansion (0.25 mm/d) at age 8.10 y *(Geran, 2006)* or rapid expansion (0.5 mm/d) at age 12.2 *(McNamara, 2003)*. Similar expansion across the molars & canines and increase in arch perimeter.
Semirapid expansion	- **0.25 mm / d**
Alt-RAMEC *Liou, 2005*	- Protocol: 1. Weekly alternation of RPE and constriction **1 mm per day for 7-9 w**. 2. Protraction face mask - Developed for cl.III cleft palate patients with anterior-posterior and mx transversal deficiency. - Aim: = Disrupt the midpalatal, lateral and posterior sutures. - Effect on mx expansion: o No difference compared to RPE alone. o 1 mm forward & downward movement of the mx. o More aggressive. - Alt-RAMEC approach is no longer recommended for mx protraction.
Implant supported expansion	- Aim = Apply the force directly to the bone to minimize pressure against the teeth. - The location of the skeletal anchors is important. - SPE is indicted to avoid rapid disruption of the suture. - Retention necessary: o Pressure of the stretched palatal mucosa and the soft tissues. o Dental relapse also occurs with skeletal expansion! o Skeletal & dental relapse without retention. o Bone borne expander should remain in place until new bone is formed in the midline suture, had time to calcify and at least partial mature. A tooth supported retainer afterwards is needed for another 6-12 m. - *Lagréve 2010:* RCT o Comparison of the percentage of skeletal vs. dental change with bone screws at the base of the alveolar process vs. convention expansion: → No sign. difference.

	- *Hourfar, 2016* / *Lin, 2015*: ○ Sign. better anchorage and less tooth movement of palatally anchored expanders compared to tooth-borne expanders.

Retention time after expansion	- <u>SPE:</u>
	  1. SPE appliance for 12 w
	  2. Tooth borne retention
	- <u>RPE:</u>
	  1. RPE appliance for 3-4 m
	  2. Removable retainer / TPA / heavy mx wire
	- <u>Implant supported expansion:</u>
	  Similar to RPE
	
	- The time that a fixed appliance is kept in place, is similar for RPE and SPE = ~3 months.
	- New bone forms along the edges of the suture at the rate of about 0.5 mm / w.
	  → With 10 mm expansion and 50% skeletal component, the width of the suture itself would be about normal at 10 weeks.

Maxillary expansion and sleep-disordered breathing	- RPE → nasal airway ↑ & nasopharynx volume ↑
	  (no data for SPE, but probably the same effect)
	- Mx expansion effects in patients with sleep-disturbed breathing:
	  ○ Nasal resistance ↓
	  ○ Apnea-Hypnoea Index ↓
	  (even in children with a severe tonsillar hypertrophy)
	  ○ Arousal index score ↓
	- RPE of mx arches with normal dimensions into buccal crossbite is justified for patients with sleep apnoe, but not for healthy patients.
	- Mx protraction does not increase the pharyngeal airway volume.

Clinical management of palatal expansion	- Bands 64+46 or V+V or 6+6 with anterior extensions.
	- *Davidovitch, 2005:*
	  4-bands vs. 2-bands appliances provides more transversal expansion and increase in arch perimeter, esp. after age 12 y when the suture is more mature.
	- Expanders with hinges allow differential expansion in the anterior and posterior arch section.
	- Bonded expander:
	  ○ Recommended for long-face patients.
	  ○ Idea: Interferes with the eruption of the posterior teeth in both arches → downward & backward rotation of the mn ↓.
	  (evidence that this is the case in short term)
	- Patients with a deep bite: The type of the expander seems to make no difference in the vertical effects of the expansion.

Treatment of transverse mn constriction	- Mn has no midline suture:
	  → Removable appliances can only move teeth.
	- Symphysis distraction is the only way to deal with problems created by missing areas of the anterior mandible.
	
	- <u>Distraction osteogenesis:</u>
	  ○ Allows mn transverse expansion.
	  ○ After cutting through the bone, the healing callus can be manipulated, and new bone generated.
	  ○ Cave:
	  ▪ Expansion anterior >> molar region
	  ▪ Condyles rotate slightly, but do not move laterally: The rotation is tolerated without creating any problems.
	  ▪ Only tx option for problems created by missing areas of the anterior mn.

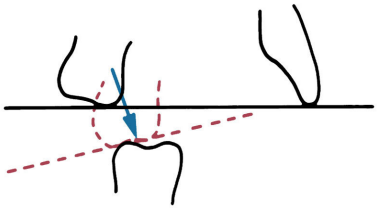
Restriction of excessive transverse growth	- Difficult but not impossible:
	  - Maxilla:
	  ○ TPA during growth maintains the molar width without affecting skeletal growth or the arch width at the canines / premolars.
	  - Mandible:
	  ○ Length of the lingual arch makes it flexible, so that some increase in intermolar width probably will occur despite its presence.
	  → Risk for posterior crossbite.
	
	- Patients with normal mx width and a large mn arch often have a wide tongue:
	  → Mx must be expanded although the mn is at mistake or the crossbite accepted when it does not provoke a mn shift.

Cl.III growth modification

Concepts of cl.III tx:
- Polygenetic malocclusion: Multiple genes are associated with cl. II malocclusion.
- Interaction between genetics and environment factors.
- Longterm retention is difficult for all tx, surgery is maybe necessary although early tx.
- If class III recurs, it's because of excessive mn growth, not because of a relapse of the maxilla.
  → Higher success if a class III is due to mx deficiency and not to mn prognathisme.
- Mx deficiency and mn excess are about equally likely for cl.III patients.
  → = ~ 50% of the patients can be treated successfully.
- Effective increase of mx growth with facemask tx is possible.
- Restraint of mn growth with a chin-cup leads mainly to downward and posterior rotation:
  → Risk to create a long face if the patients doesn't have a short anterior face height (like it is often the case for Asians)
- Cl.III elastics on skeletal anchors:
  - More efficient to bring the mx forward compared to facemask.
  - Alterations in mn growth occur.
- Patients with a mx deficit often also have blocked-out mx canines.

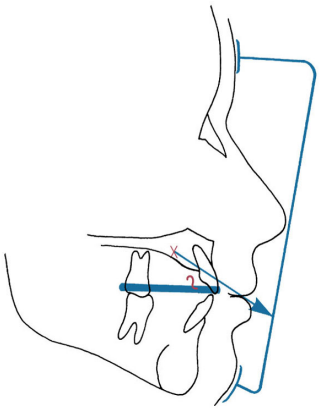
- *Wolfe 2011*: Characteristics of cll.III patients.
  - Mx: ø smaller, but more retrusive. Difference in size develops early.
  - Mn: Larger & protrusive → cumulative anterior-posterior growth.
  - Anterior face height ↑.
  - More hyperdivergent jaw orientation.
  - Cl.III pattern can be diagnosed before the pubertal growth spurt.

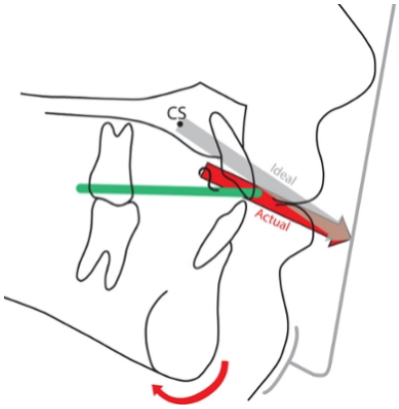
Anteroposterior and vertical maxillary deficiency

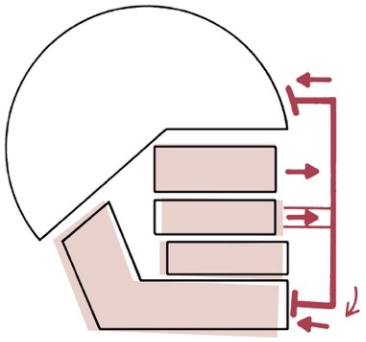
Direct effect	Maxilla is small or posteriorly positioned.
Indirect effect	Maxilla does not grow vertically → Mandible rotates upward and forward as it grows.
FR-III Functional Appliance (least effective tx approach)	- Effects: o The mandible is positioned posterior and rotated open. o Pads to stretch the upper lip forward (should stimulate mx growth). o Mx molars can erupt and move mesially while the lower molars are hold in place vertically & anterior-posterior. o Upper incisors tip facially, lower incisors are retracted. o Rotation of the occlusal plane down posteriorly: Eruption upper molars > lower molars   - Little / no true forward movement of the upper jaw, most of the improvement is achieved by dental changes. - Long tx and retention periods which demand compliance. - → Functional appliance tx has little / no effect on mx deficiency. - → Use indicated only in mild cl.III cases.
Reverse-pull HG (Facemask / Delaire) (medium effective tx approach)	- Applied easier and more effective at young age: • > 8 y: Chance of true skeletal changes declines. • 10-11 y: Chance of clinical success declines. - Some tooth movement is inevitable: o Forward displacement of maxillary teeth. o Backward displacement of the mandibular teeth. - No difference in the amount of anterior-posterior changes with simultaneous palatal expansion → perform expansion only if it is necessary. - 25-30% of patients with previous facemask tx end in an anterior crossbite after the adolescent growth: The mn outgrows the mx in patients with excessive mn growth.

- Indication:
  - Children with minor to moderate skeletal problems:
    Teeth are within some mm of each other when they have a correct axial inclination.
  - True maxillary problems.
  - Better wait for tx until permanent 1st molars & incisors have erupted.
  - Low angle cases respond better than high angle cases.

- Appliance design:
  - **350-450 gm** of force per side.
  - Wear time 12-14 h from the early evening until the next morning. (use growth hormone release)
  - Slight downward direction of the elastics is often desired for some vertical effect.
    Franchi: **13-30°**, **elastic length = distance of the attachments / 3**.
  - Hooks in the canine - primary molar area above the occlusal plane:
    → Force vector is closer to the center of resistance of the mx and rotation is minimized.
  - If the line of force is below the center of resistance of the maxilla:
    → Downward rotation of the posterior part of the maxilla and opening of the bite anterior can be anticipated.







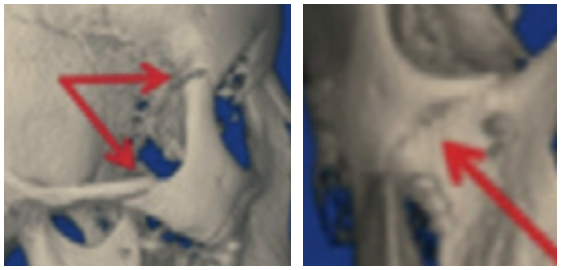
Forward traction against the maxilla typically has three effects:
(1) Some forward movement of the maxilla, the amount depending to a large extent on the patient's age.
(2) Forward movement of the maxillary teeth relative to the maxilla.
(3) Downward and backward rotation of the mandible because of the reciprocal force placed against the chin.

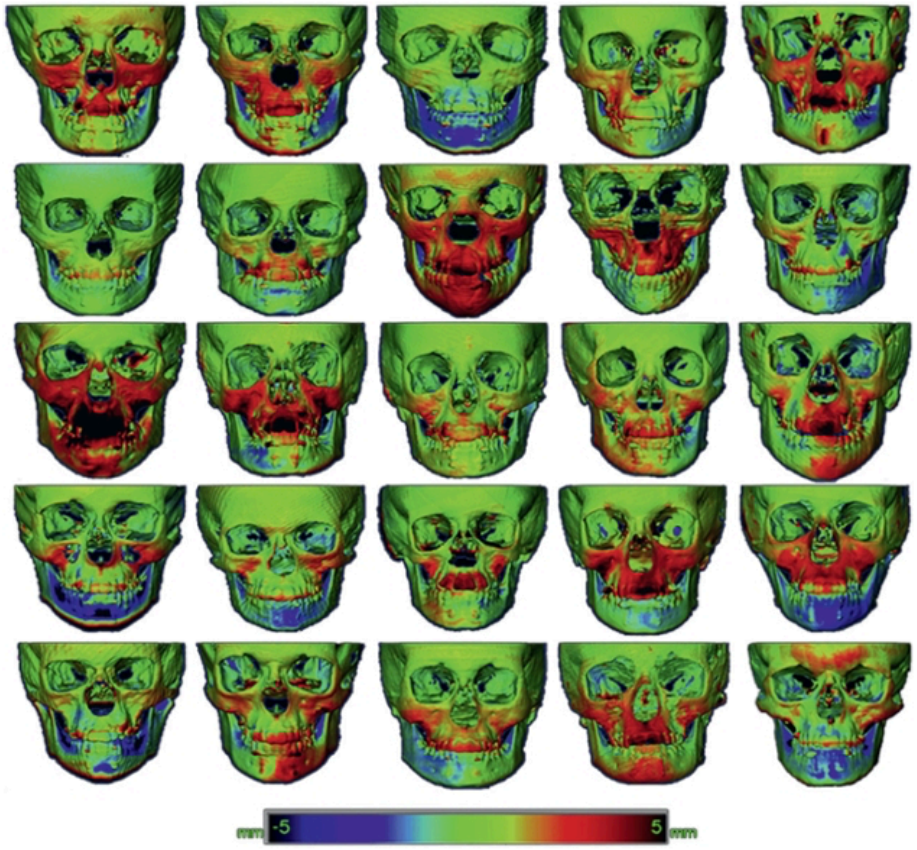
- <u>Alt-RAMEC:</u>
  - Mx mobility ↑
  - Compression of the facial sutures?
    Cave: **Gli1+** cells within the craniofacial sutures are critical for formation of all craniofacial bones and are activated during injury repair. Their loss is associated with craniosynostosis.
  - Only about 1 mm more protraction can be achieved compared to a conventional protocol. → stat. significant, but not clinically sign.

  → NOT indicated: Minimal benefit with risk for injury.

- *Franchi*:
  Prognostic factors for success with facemask and RPE tx for cl.III malocclusion:
  1. Long ramus mandibulae: 0.3x
  2. Big saddle angle: 0.2x
  3. Big mn angle: 0.1x

  → Predictive power total = 84%

	- <u>Facemask traction to skeletal anchorage:</u> o Skeletal change > compared to dental anchorage. o 4-5 mm maximum advancement limit. o Single alveolar bone screws are not sufficient → miniplates necessary. Cave: Enough bone density for skeletal anchorage is reached after the window for facemask tx.
Cl.III elastics to mx and mn miniplates (most effective tx approach)	- Introduced by *De Clerck, 2010 (mx) & 2012 (mn).* - Miniplates bilateral at the base of the zygomatic arch and the antero-lateral surface of the mn (minimum age 10.6-11 y) or ankylosed primary molars. - Tx timing: Ideal: About 1 y tx at age 12-14 y (adolescence growth spurt). o Enough bone density for skeletal anchorage ~ 11 years. o Mn plate insertion not before the eruption of 3-3. - Ideal force: **150-250 g per side** (not more), wear elastics continuous. - A biteblock may has to be adopted for correction in case of an anterior crossbite. - Leave the plates in place after tx for retention or in case of later growth. - Promising approach for patients approaching adolescents: o Higher levels of skeletal change. o 24 h force application possible. o Remodeling of the TM-fossae observed. o $^1/_3$ of patients show an opening of the zygomaticofrontal and zygomaticomaxillary suture. *Note: According the illustration zygomaticotemporal not zygomaticomaxillary suture.*  o 80% show a favorable result of the facial outcome and 32% a highly favorable outcome (great differences). o Mn growth can be reduced or stopped.



- Mx protraction does not increase the pharyngeal airway volume:
  → No indication to treat sleep apnoe.
- Mx plates can also be used to distalize posterior teeth to create space if necessary.
  (3+3 often blocked out in mx deficient patients)

- *Cevidanes, 2010:*
  <u>Cl.III elastics on mx & mn plates vs. facemask with dental anchorage:</u>
  - Facemasks patients are younger: 8.3 y vs 11.10 y.
  - Facemask uses larger forces: 300-500 gm vs. 150-200 gm.
  - Miniplates: In average 2.5-3 mm more mx movement (max. maxillary advancement with miniplate = 4-5 mm)gv
  - Midface changes observed in 32% of the miniplate group. Not seen in the facemask group.

- *Sar, 2011 & 2013:*
  <u>Cl.III elastics on mx & mn plates vs. facemask with skeletal anchorage:</u>
  - Facemask patients are younger: 10.9 y vs. 11.10 y.
  - Miniplates show about twice as much change.
  - Similar changes for facemask with skeletal or dental anchorage.

- Cave: No longterm results available. Some loss of the correction must be expected. because growth continues in the initial pattern. But promising tx approach.

Mandibular excess

- No tx for children with severe prognathisme until surgery can be done.
- Asian people: Benefit more from camouflage tx with chin rotation: short anterior face height, mild class III.

Functional appliance for tx of excessive mandibular growth

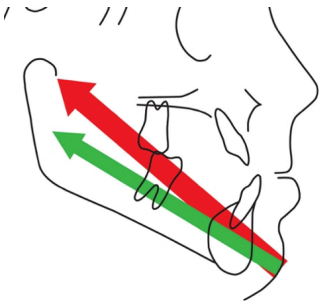
- Principle:
  - No restraint of the mn growth is possible.
  - Down-/backward rotation of the mn to guide the eruption of the teeth:
    Upper posterior teeth erupt down-/forward.
    The eruption of lower teeth is restrained.
    → Occlusal plane rotates in clockwise direction.
- Side effects:
  - Tipping of mn incisors lingually, mx incisors facially:
    = camouflage for the skeletal discrepancy.
  - Risk of creating a long-face problem.
- Working bite:
  Mandible rotated open (3 to maximum 5-6 mm) on its hinge axis, but no advanced.
- Indicated only for patients in whom a large and prominent mn is combined with vertical mx deficiency.

Chin-cup

- Idea:
  Heavy force (**16 ounces per side = 450 g**) (1 ounce = 28.3 g) aimed directly at the condyles would correct excessive mn growth by inhibition of condylar growth.
  → Not true: Little evidence that eo force directed against the mn condyle restrains growth at that location in humans.
  → Probably ineffective because growth modification requires light forces with long duration.

- Effect of chin cup tx = functional appliance:
  - Chin rotates down- & backwards
    → Chin is less prominent + anterior face height increases.
  - Mandibular incisors tip lingually
    (chin cup or strap closer to the lower lip → incisor tipping ↑)

- Now that it is accepted that it produces mainly rotation, lighter force below the condyle is recommended to produce more rotation.



- Transient restraint of growth is likely to be overwhelmed by subsequent growth and often even compensatory growth (rebound effect).
- No evidence that TMJ problems could develop because of chin-cup tx.

- <u>Indication</u>:
  - Limited application
  - Often works as transient camouflage but children end up in surgery.

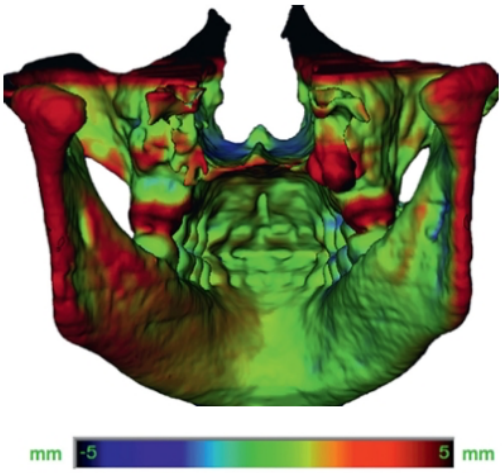
Cl.III elastic to skeletal anchors

- *De Clerck 2012:*
  - Posterior displacement of the mandible at the condyles and of the posterior ramus have been observed (remodeling of the condyles and/or fossae).
    Cave: Posterior displacement can also result from down-/backward growth of the TMJ area.
  - Mean change at the chin is essentially zero.
  - 50% patients with some net forward movement of the chin.

- Possible effects on the mandible in detail:
  - Backward movement of the chin 4-5 mm (rare 3/25 cases) by redirection of vertical growth at the condylar fossa and modeling of both the fossa and condylar head.

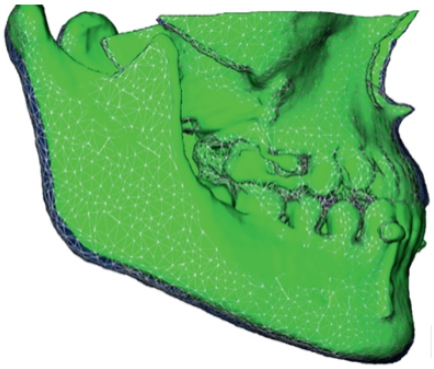
- Normally the point of articulation of the mn with the temporal bone does grown straight downwards in relation to the cranial base:
  → Lengthening of the mn results in chin projection.
- Sometimes the direction of growth has a backward component → compensates for growth in cl.III patients.

- Condyle modeling goes on throughout life (occurs after orthognathic surgery and during growth). Modeling of the inferior surface of the condylar fossa also occurs in some patients.
- 80% of treated cases show no sign. forward movement of the mn like it would have been expected for an adolescent group. The mn growth was expressed as backward movement of the condyles.



- Unusual mn remodeling in most patients:
  - Slight backward movement of the condyles and the ramus
  - Gonial angle ↓
  - Mn plane angle ↓

  → Bending of the mn occurs that limits forward movement of the chin although growth occurs.

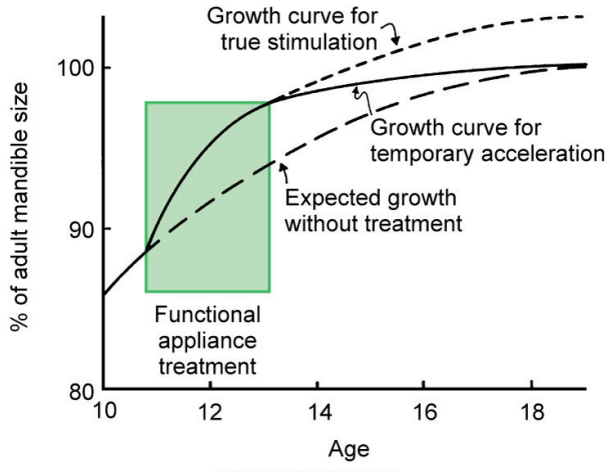


This detailed superimposition of the mandibular change in a typical patient is still another unexpected finding: what amounts to a bending of the mandible at the gonial angle, so the chin is not projected forward as much as it would have been if the inclination of the ramus to the mandibular body had not been changed by the pattern of modeling with the consistent Class III elastic force.

- Difficult to determine if the major effect is on the mx or the mn, how to arrange tx and long-term effects.
- Effect on both jaws is an improvement compared to “treating” only one jaw.
  Cave: Mx effect may goes beyond what was desired.
- No data exist to document the extent to which further growth after tx will lead to a recurrence of the malocclusion.

Proffit Chapter 14:

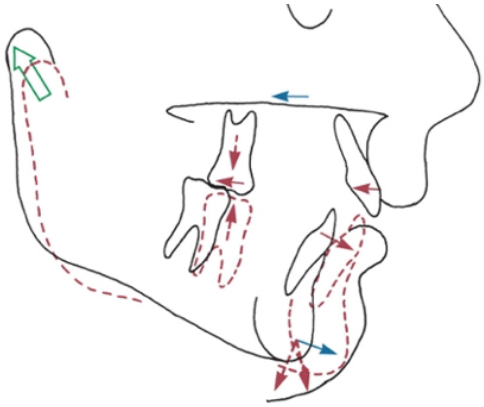
Growth Modification in Class II, Open Bite / Deep Bite and Multidimensional Problems

Cl.II growth modification	
Compontents of cl.II	- Deficient forward movement of the mn. - Excessive mx growth: more likely to be downward than forward.
Evolution of cl.II growth modification tx strategy	- Late 1800s: HG tx used in the US, but later abandoned. Not because it was inefficient, but because Angle thought the effect is the same with cl.II elastics. - Angle: Use of cl.II elastics in the believe to stimulate growth of the mn. - Introduction of cephalometry: Acknowledgment that cl.II elastic mainly move the lower teeth forward without much skeletal effect.
Principles for augmentaiton of mandibular growth	- Passive = Mandible is held forward by the orthodontic appliance. - Active = Patient responds to the appliance by using the muscles. → Functional appliance (specific term activator). - Changes can occur on the temporal and mandibular side of the TMJ. - Sometimes little effect on the malocclusion as the articular fossa remodels posteriorly, while the mandible grows longer at the same time. - Holding the mandible forward passively needs a few 100 g of force. If the musculature relaxes → Reactive force is distributed on the maxilla → Restraint of maxillary forward growth. - An active / passive tx approach may does not affect the amount of mandibular growth, but it affects how much tooth movement occurs and may determines the skeletal effect on the maxilla.
Perspecitves on growth modification	 • **Absolut stimulation:** = Attainment of a final size larger than it would have occurred without tx. • **Temporal stimulation:** More growth during a given period than it would have been expected without tx = acceleration of growth. - Individual variation, but the response to a functional appliance is most often similar to the solid line. - Cephalometric superimposition often shows more mn growth in the first month of functional appliance tx than would have been expected. This is likely to be followed by a decrease in growth later. - *Perinetti, 2015*: Timing mn growth modification to coincide with the mn growth spurts can provide growth changes beyond what usually occurs.
Functional appliance	- = Appliance that changes the posture of the mn and causes the patient to hold it open and/or forward for cl.II correction or backward for cl.III correction. - Original idea of tx effect: Additional growth is supposed to occur in response to the movement of the mn condyle out of the fossa mediated by reduced pressure on the condylar tissues or by altered muscular tension on the condyle. → Theory not supported by data and largely discarded. - Temporal growth stimulation: More growth in the first months of tx with the appliance, followed by a decrease in growth later.

- Same mandibular size at the end in treated and untreated cases.
- Mx dental retraction and mn dental protrusion is similar to the effect of interarch elastics
  → Cave: Functional appliances are not indicated for patients with protruded lower incisors.

- <u>Reactive elastic stretches of the soft tissues:</u>
  - Growth at the condyles is maybe accompanied by repositioning of the articular fossa by apposition of bone on its posterior wall.
  - Lower teeth move forward.
  - Upper teeth move backward.
  - Rotation of the occlusal plan backward.
  - Restraining force on forward growth of the maxilla (HG effect).

  → Any combination of these effects is possible in patients.
  → The direction to which mn growth is expressed is most related to the eruption of the molars: if molar eruption > growth of ramus in height → forward mn change will be negated, cl.II malocclusion will not improve.

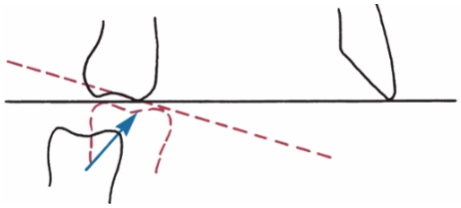
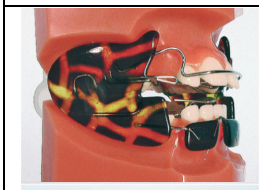


- HG effect is observed in most functional appliance tx that position the mn anterior. This is presumably because the soft tissues are stretched when the mn is advanced and this force is transferred to the mx.
- Extreme lingual tipping of the mx incisors during functional appliance tx usually reflects a failure of the child to keep the mandible positioned forward while wearing the appliance.

- *<u>Nucera, 2016:</u>* <u>Evidence for the effects of functional tx</u>
  - Acceleration of mn growth is possible.
  - Modest change of the size of the mandible's overall length: 0.16 mm/m (over several types of appliances).
  - Often reorientation of the mx and the mn facilitated by a clockwise tipping of the occlusal plane and a rotation of the mx, the mn or both.
  - Mx forward growth ↓ (HG-effect) to < 1 mm/y.

- *<u>O'Brien, 2009</u>*: <u>Twinblock</u>
  - Equally successful to stimulate mn growth in preadolescents or at the peak of growth spurt.
  - Produced changes:
    - 40% skeletal
    - 60% dental:
      - lower arch forward
      - upper incisor tipping backwards (25%)

- <u>Leveling the curve of Spee:</u>
  - Blocking the eruption of the lower incisors while leaving the lower posterior teeth free to erupt up and forward.
  - Upper posterior teeth are prohibited from eruption and forward moving .
    → Posterior upward rotation of the occlusal plane that corrects cl.II relationship.

	 ○ Eruption of posterior teeth is effective only in patients with good vertical growth: Eruption of posterior teeth > growth of the ramus → mn growth projected downward > forward
 	- **Bionator:** The bionator is tooth borne (passiv) and induces mandibular advancement with contact of lingual flanges with the lingual mucosa. It usually has a buccal wire to maintain the lips off the teeth and can incorporate bite blocks between the posterior teeth and a tongue shield as this one does. The bionator also incorporates a major palatal connector to stabilize the posterior segments, but the appliance is limited in bulk and relatively easy for the patient to accommodate. - **Activator:** The activator is also used to actively advance the mandible and can incorporate anterior and posterior bite blocks and a labial bow. The activator's lingual shields usually extend deeper along the mandibular alveolus than other functional appliances, and sometimes the appliance incorporates a displacing spring so that the patient has to close down and advance the mandible in order to retain the appliance in place. The theory is that activating the mandibular musculature is important in obtaining a growth effect (thus the activator name), but this theory has not been supported by data and has largely been discarded.
 	- **Frankel-II appliance**: It actively advances the mandible via contact of the lingual pad behind the lower incisors with the mucosa in that area and fosters expansion of the arches with the buccal shields. The lower lip pad also moves the lower lip facially. The appliance is largely tissue borne and potentially causes more soft tissue irritation than other functional appliances, but a patient can talk normally with it in place, which makes full-time wear feasible. Because of the wire framework, it is more susceptible to distortion than functional appliances made largely with plastic.
	- **Twin-Block:** The Twin-Block functional appliance (active) is retained on the teeth with conventional clasps, but can be cemented in place: if the upper part is cemented → higher chance that both parts will be worn because it is more comfortable. The complementary inclines on the upper and lower portions are relatively steep (min. 70°), forcing the patient to advance the mandible in order to close. The plastic blocks also can be used to control posterior eruption.
Headgear	- First use in the 1800s in the US and reintroduced 1940 (*Silas Kloehns*) - Idea: Restraint of the maxillary growth with EO force while letting the mandible continue to grow normally to catch up. - The dental vs. skeletal effect can be influenced by the amount of force applied. - Effect on the mx dentition: ○ 6+6 tip distally. ○ Premolars often migrate distally. (force transmitted by supracrestal fibers) ○ Vertical effect on 6+6: Extrusion vs. intrusion. True intrusion normally does not occur, but downward movement of the mx and the posterior teeth is impeded. ○ Distalization of teeth → bite opening effect anterior.

	- Effect on the mn: • No effect expected. • Growth restraint never happens. • Some studies show improvement of mn growth and chin prominence during HG tx. (*Keeling, 1998)*
Evidence from RCTs: Functional appliances vs. HG - *Tulloch, 2004. University of North Carolina.* - *Keeling, 1998. University of Florida.* - *O'Brien, 2009. University of Manchester.*	- <u>Comparison of early 2-stage tx versus later 1- stage tx:</u> • Children treated with either HG or functional appliance had a small but stat. sign. improvement in their jaw relationship during the tx period (late preadolescence & early adolescence), whereas the untreated children did not. • Changes in the skeletal relationships created during early tx were at least partially reversed by later compensatory growth in the HG and functional appliance group. • Similar skeletal relationship between the former control and the early tx groups by the end of phase 2. • No difference in PAR scores. (reflects alignment and occlusion) • Functional appliance tx tended to increase the need for extractions. • At the end of phase 1, treated children reported anxiety ↓, self-concept ↑, physical appearance ↑, popularity ↑, happiness ↑ and satisfaction ↑ than controls. The differences disappeared however by the end of phase 2 tx. - <u>Conclusions</u> • Skeletal changes are likely to be produced by early tx with HG or a functional appliance but tend to be diminished or eliminated by subsequent growth and later tx. • Skeletal changes account for only a portion of the tx effect, even when an effort is made to minimize tooth movement. • After later comprehensive tx, alignment and occlusion are very similar in children who did and did not undergo early tx. • Early tx does not reduce the number of children who require extractions during a second phase of tx or the number who eventually require orthognathic surgery. • The duration of phase 2 tx is quite similar in those with and without a first phase of early tx aimed at growth modification. - For most children with cl.II problems, early tx is not more effective than later tx. → It is more efficient to modify growth during the adolescent growth spurt than before adolescence. - Psychosocial benefits are equally likely with early or later cl.II growth modification. - Early tx is still indicated for patients with large OJ, esthetic concerns or psychosocial problems.