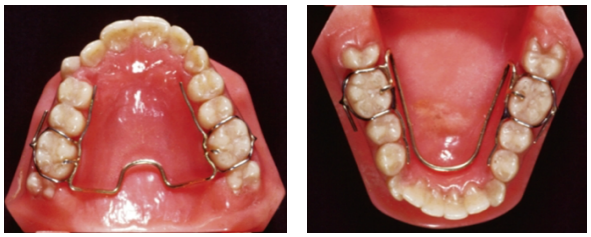
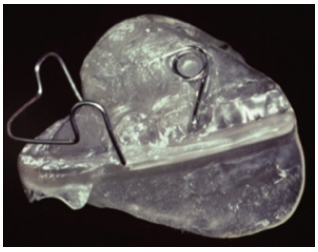
Chapter 10:

Contemporary Orthodontic Appliances

<table>
<tr><th colspan="2">Removable appliances</th></tr>
<tr><td>Pros and contras</td><td>- Cons:
o Compliance depending.
o Difficult to obtain a two point contact on the teeth:
→ Complex tooth movements are difficult to achieve.
- Pros:
o Fabricated in the laboratory → reduced chair time.
o Removal on socially sensitive events, almost invisible.
o Some type of growth guidance tx possible that cannot be carried out readily with fixed appliances.</td></tr>
<tr><td>History and development</td><td>- America:
• Tx was used to be based on fixed appliances.
(Angel's doctrine to place every tooth precisely)
• Introduction of removable appliances only 1960/70 after an American study that showed that significant skeletal changes can be achieved with removable appliances.

- Europe:
• Precious metal was less available.
(precious metal in dentistry was banded by the Nazis)
• Social welfare system that placed the emphasis on limited tx, but for a large number of people.

- 1900: Monobloc by Robin

- Early 1900s: George Croza (US)
o Removable appliance fabricated entirely of precious metal.
o Clasps for the molars.
o Heavy gold wire as frame work.
o Lighter gold fingersprings.
 
- 1908: Activator by Andresen: (without knowing the monobloc by Robin)
o Angulated flutes in the acrylic to guide eruption of the teeth.
o Displacement spring in the palate:
→ patient must bite into the activator to keep it in place.
o Loosely fitting:
→ Was thought to activate the musculature, but nowadays not supported by research → clasps preferred.
o 1925: Andresen become professor in Oslo and gains a lot of clinical expertise with the activator.
  </td></tr>
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<tr><td></td><td>
- Häuptl (Germany):
Recognizes that the only stable tooth movement was produced by natural forces and that alteration in function by the new appliances would give stable correction of malocclusion.
(total contrary to Angles belief in the US!)
1936: Publication of the book “Funktionskieferorthopädie” with Andresen.

- Martin Schwarz:
○ Split plate with jackscrew to expand arches.
○ Arrowhead clasp.

- Philip Adams: Adams crib.

- 1970: Animal experience showing that skeletal changes really could be produced by posturing the mandible to a new position + hypothesis that true stimulation of mandibular growth could be achieved.
</td></tr>
<tr><td>Functional appliances for growth modification</td><td>
- Functional appliance:
Change of the posture on the mandible → pressure created by the stretch of the muscles and soft tissues are transmitted to the dental / skeletal structures → movement of teeth or modification of growth.
= Depends only on soft tissue stretch and muscular activity to produce the desired effects.

TABLE 10.1 Functional Appliance Components

<table>
<tr><th>Component</th><th>Comment</th></tr>
<tr><td colspan="2">Functional Components</td></tr>
<tr><td>Lingual flanges</td><td>Contact with mucosa; most effective</td></tr>
<tr><td>Lingual pad</td><td>Contact with mucosa; less effective</td></tr>
<tr><td>Sliding pin and tube</td><td>Contact with teeth; variable tooth displacement</td></tr>
<tr><td>Tooth-supported ramps</td><td>Contact with teeth; tooth displacement likely</td></tr>
<tr><td>Lip pads</td><td>Secondary effect only on mandibular position</td></tr>
<tr><td colspan="2">Tooth-Controlling Components</td></tr>
<tr><td colspan="2">Arch Expansion</td></tr>
<tr><td>Buccal shields</td><td>Passive, effective</td></tr>
<tr><td>Buccinator bow, other wire shield</td><td>Passive, less effective</td></tr>
<tr><td>Expansion screws and/or springs</td><td>Must activate slowly; questionable stability</td></tr>
<tr><td colspan="2">Vertical Control</td></tr>
<tr><td>Occlusal or incisal stops</td><td>Prevent eruption in discrete area</td></tr>
<tr><td>Bite blocks</td><td>Prevent eruption of all posterior teeth</td></tr>
<tr><td>Lingual shield</td><td>Facilitate eruption</td></tr>
<tr><td colspan="2">Stabilizing Components</td></tr>
<tr><td>Clasps</td><td>No effect on growth modification</td></tr>
<tr><td>Labial bow</td><td>Keep away from incisors, lingual tipping undesirable</td></tr>
<tr><td>Anterior torquing springs</td><td>Needed to control lingual tipping, especially with headgear-activator combination</td></tr>
</table>

- Construction bite:
○ Cl.II: Mn is advanced.
○ Cl.III: Mn is rotated downward.
</td></tr>
</table>

- 4 Categories:
  1. <u>Passive tooth-borne:</u>
     - No intrinsic force-generating capacity from springs or screws.
     - Depends only on soft tissue stretch and muscular activity to produce the desired effects.
     - Examples: Bionator, Herbst appliance, bonded twin block

     - **Carrier motion appliance:**
       - Pro: Minimal lateral restriction of the mn movement.
       - In theory forces are similar to a Herbst appliance, but good studies are not available.

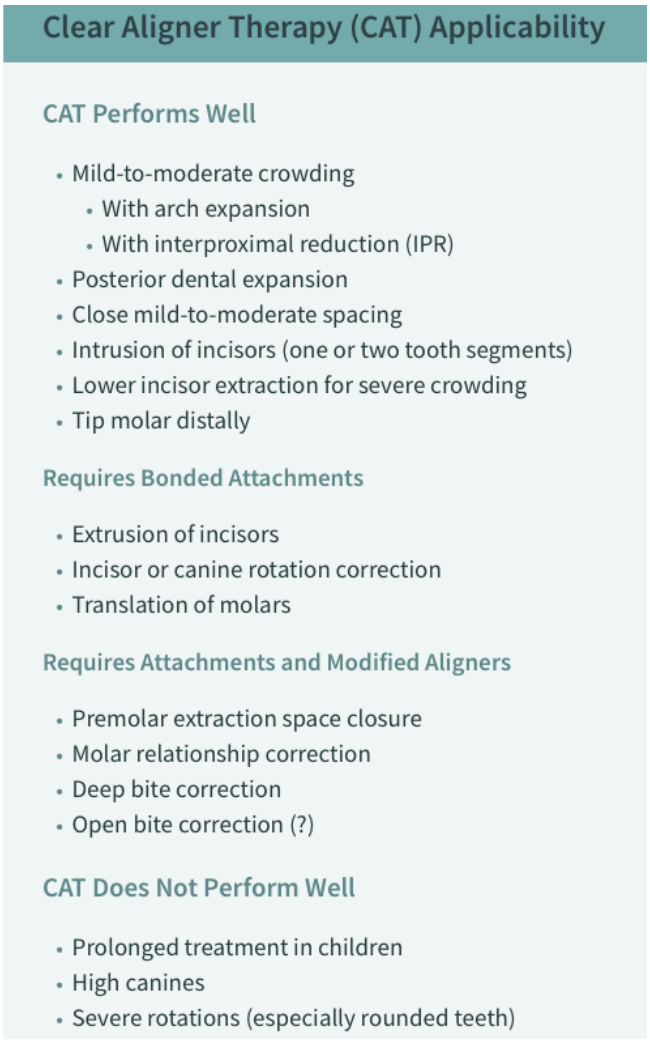
     - **Forsus:**
       Compared to Herbst appliance:
       - Skeletal effect on mx growth ↑
       - Forward movement of the mn dentition ↑
       - Skeletal mn advancement ↓

  2. <u>Active tooth-borne:</u>
     - Expansion screw or springs to move teeth.
     - Produce tooth movement that often replaces jaw growth / modification with camouflage tooth movement.
     - Used much less than previously.
     - Examples: Modified activator / bionator

  3. <u>Tissue- borne:</u>
     - Contact of the appliance with the teeth is avoided.
     - Hold the lips and cheeks away from the dentition.

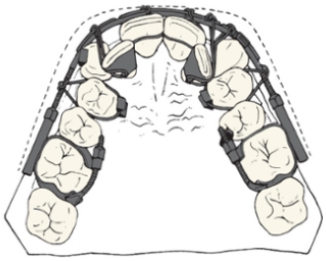
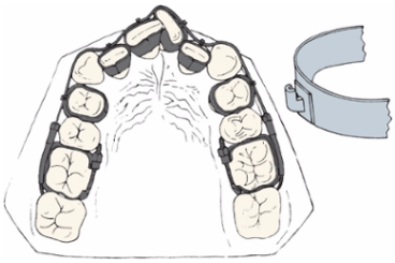
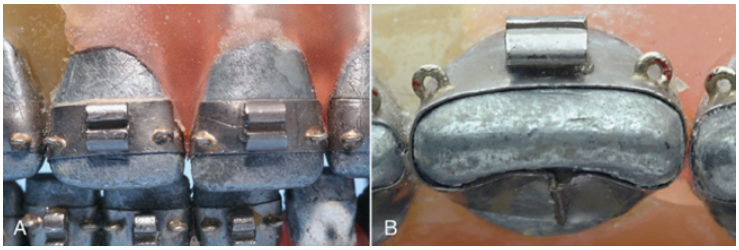
     - **Frankl appliance:** (1969)
       - Large buccal shields and lips pads reduce cheek and lip pressure on the dentition and provide the expansion of the maxillary arch.
       - Lingual pads dictate the mn position.
       - Effective but needs a long tx time (+/- 5 y).
       - Available for cl.II, cl.III and open bite.
       - Most parts of the appliance are restricted to the buccal vestibule:
         → Speech is easier and 24h wear easier.

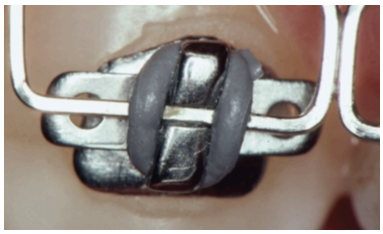
	4. <u>Hybrid:</u> o Components that are common to functional appliances but are combined to meet for specific needs. o Often used for tx of jaws asymmetry. o Used primary in late preadolescent children and during adolescent growth spurt.
Important factors for removable appliances	- Compliance: If it is not high at the beginning it will decrease (known from studies). → Change tx plan for noncompliant patients. - Right timing.
Removable appliances for tooth movement in children	
Active plate for arch expansion	- Activation of the screw produces a heavy force which decays rapidly. - If the screw is activated too rapidly → appliance is displaced from the teeth rather than the arch is expanded.
Removable appliances with springs for tooth movement	- Nearly optimum light continuous forces can be produced by the springs. - Only one-point contact with the tooth → other movements than tipping difficult.

<table>
<tr><th colspan="2">Clear aligner therapy</th></tr>
<tr><td>Development</td><td>- 1980s: Introduction of vacuum formed aligners.
- Initially used for retention proposes.
- Late 1990s: Computerization of the process of producing a sequence of casts with incremental changes on which aligners could be fabricated.</td></tr>
<tr><td>Indication</td><td>- Only small amount of tooth movement possible with one aligner:
(elastic range = ~ 0.2 mm, maximum stress of plastic = ~ 1 mm)
→ reshape the aligner, make a new one.
- Satisfactory for simpler cases, extra instructions by the doctor needed for complex tx.
- Accuracy ratio achieved to predicted changes: 18-47% depending on the tooth movement.
- Bleaching is possible with aligners. Better after tx, because teeth are already sensitive during tx. Tooth movement and bleaching create a transient pulpitis.
- Bite ramps on the incisors to disclude posterior teeth can prevent transient posterior intrusion as arches are leveled.
- Bite blocks between posterior teeth can help to close an anterior open bite by intrusion. Cave: Historically bite blocks have not been effective in doing this and much of the bite closure is likely to be incisor elongation.
 

- Possible causes if teeth do not track the tx plan:
○ Insufficient wear of the aligners
○ Insufficient IPR
○ Insufficient crown height or shape to allow a grip on the tooth to be moved
○ Wrong type or position of bonded attachments
○ Movement created in the clean check that is too fast to be biologically possible.</td></tr>
</table>

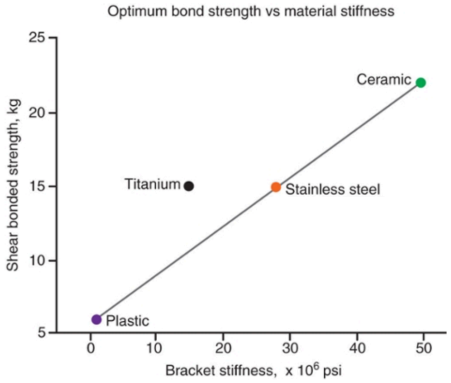
Invisalign production	1. IO scan or impression, bite registration. 2. Digitalization. 3. Tx stages following the doctor's instructions. Cave: Sequence of steps and the amount of movement between steps is specified by algorithms in the software: → The preliminary plan is placed online for clean check. 4. Fabrication of stereolithographic models and formation of a plastic retainer over each model. 5. IPR / bonded attachments → Extension of possible tooth movements. 6. Verify that the tooth movements are tracking with the series of aligners during tx (enough worn / IPR, correct bonded shapes, enough grid on the teeth). - Midcourse correction refinement if necessary.

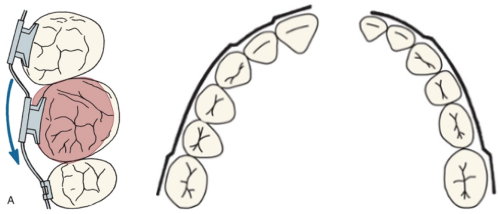
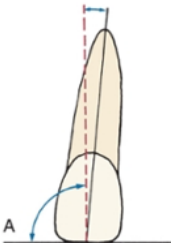
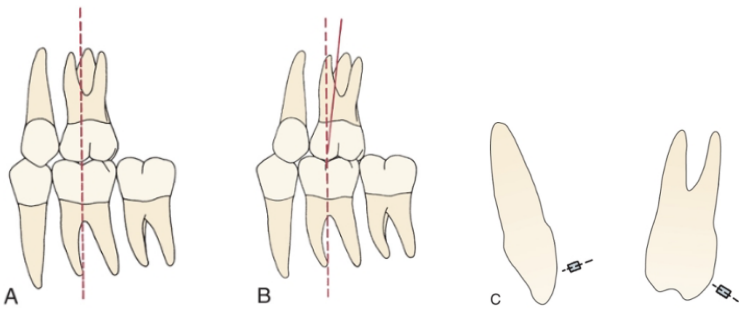
Fixed appliances	
Edgewise appliance	- Rectangular archwire in a rectangular slot. - All contemporary appliances today except Begg appliance (=ribbonwise).
History	- <u>Angle's progression to the edgewise appliance</u> **1. E-Arch late 1800's:** • Bands around molars + heavy labial archwire. • Teeth tied to the arch for expansion → only tipping. • Mechanism to advance the arch and increase the perimeter.  **2. Pin and Tube:** • Bands on other teeth with a vertical tube on each band into which a soldered pin from a smaller archwire was placed. • Great precision possible, impractical for use. **3. Ribbon Arch:** • Vertically positioned rectangular slot behind the tube. • Ribbon archwire 10x20 gold placed into the vertical slot and hold with pins. • Good spring qualities. • Relatively poor control of root position (too much resiliency of the archwire)  **4. Edgewise** • Slot orientated horizontal, 22x28 mils. • Precious metal wire 22x28 mil used after extensive experimentation: → excellent control of crown and root position in all 3 planes of space. • Rectangular wire 90° rotated compared to the ribbon arch → wider than small → could be twisted to create torque. • Eyelet at the corner of the bands with the brackets.  - <u>Labiolingual appliance:</u> (Disappeared nowadays) • Bands on the molars. • Heavy labial and lingual archwire. • Fingersprings soldered to the archwires to move individual teeth. - <u>Twin wire appliance</u>**:** (Disappeared nowadays) • Bands on the molars and incisors.

	• Twin 10 mil steel archwires for alignment of the incisors, protected by long tubes which extended forward from the molars to the canines. - <u>Begg Appliance: (Australia, 1940-1950)</u> • = Modification of the ribbon arch attachment: ○ Precious metal ribbon arch replaced with high-strength 16 mil round stainless steel wire. ○ Brackets turned upside down → Bracket slot pints gingival. ○ Auxiliary springs for control of the root positions. • Minimal friction (small contact between the archwire and the bracket). • Binding minimized with the technique of tipping / uprighting = angle of contact between the wire and the corner of the bracket minimized.  • Anchorage control similar to Tweed: 2 steps to compensate for resistance to sliding. • Popular in the 1960s, because it was more efficient than the edgewise appliance of this time. • Still in use, but often in a hybrid form with brackets that allow the use of a rectangular wire. - <u>Charles Tweed (US, 1940-1950):</u> • Adapted Angle's edgewise appliance to extraction tx. • Anchorage control with the subdivision approach: 2 steps to compensate for resistance to sliding.
Contemporary edgewise	- More efficient than the Begg appliance. - Automatic rotational control: • Use of twin brackets or single brackets with extension wings that contact the underside of the archwire.  • No use for additional ligatures (compared to Angle). - Alterations in bracket slot dimension: Mainly 18 or 22 mil. - <u>Straight-wire prescriptions by *Andrews (1989)*</u>: Bracket modification for specific teeth to eliminate the many repetitive bends in archwires: • **First order / in-out bends:** Built in the bracket base itself by varying the thickness of the base. Faciolingual bends are not completely eliminated because of individual variations in tooth thickness. • **Second order / tip bends:** Mesiodistal position of the root given by the angulation of the bracket or bracket slot in relation to the long axis of the tooth. • **Third order / torque bend:** Bracket slots are inclined to compensate for the inclination of the facial surface. • Angulation and torque values built in the bracket = **appliance prescription.** → Precise position only of average teeth.

Bands for attachments	- <u>Indications for banding:</u> • Teeth that will receive heavy intermittent forces against the attachments (e.g. HG): → Better resisted by a steel band than by a bonded attachment. • Teeth that need both labial and lingual attachments. → Isolated lingual attachments are at risk to be swallowed or aspirated if something becomes loose. • Teeth with short clinical crowns: → Bands can slightly displace the gingiva as they are carried into proper position • Teeth with extensive restorations (low bond strength on porcelain…) - It is not appropriate to place routinely bands on all teeth! - Avoid bands in periodontal compromised patients. - Trend to bond attachments on all teeth instead of bands. - <u>Steps in banding:</u> 1. Separating spring 1 week or elastomeric separators for several days (not >2 w). 2. Place the band by hand on the m/d surface, bring it down close to the height of the marginal ridge. 3. Drive the band into place by pressure on the mb and distolingual surface. (preformed bands are designed to be fitted in a certain sequence by the manufacture's instruction) 4. Bite force on the distolingual corner. The force should be supplied by the masticatory muscles of the patient → Patients can bite harder and with more control. 5. Cement: composite of glass ionomer and resin material. Coat all interior surfaces. Cover the collar surface so that the cement is expressed from the gingival and the occlusal margins. - Fitting a band involves stretching the ss over the tooth surface. → This simultaneously contours and work-hardens the initially rather soft band.
Bonded attachments	- Bonding is based on mechanical locking of an adhesive to irregularities in the enamel surface and mechanical locks formed in the base of the orthodontic attachment. - Preparation of the tooth surface: 1. Remove pellicle. 2. Etch 20-30 s with 37% unbuffered phosphoric acid: → A small amount of the softer interprismatic enamel is removed and pores between the enamel prisms opened. Immediate remineralization in case of contamination with salvia. - Surface of attachment: Bracket base is manufactured to achieve a mechanical interlock between the bonding material and the attachment surface. - Ceramic brackets: Chemical bonding or mechanical interlocking is possible. → <u>High strength of chemical bonding can become a problem for debonding.</u>
Bonding materials	- Characteristics: ○ Dimensionally stable. ○ Quite fluid that it penetrates the enamel surface. ○ Excellent inherent strength. ○ Easy to use clinically. - Standard: = light-activated acrylic resins (bis-GMA). - Trend towards self-etch primer adhesive resin cements. (difficult to receive enough bond strength up to now) - **Modified glass-ionomer cements:** ○ Less decalcifications around the brackets due to fluoride release. (no RCT available, but convincing indications in other studies) ○ Cave: Less strength even when some composite resin is included in the bonding material ○ Increase of bond strength: ▪ 1. 25-30 s phosphoric acid etching

	▪ 2. **5% NaOCl** to deproteinize the enamel surface ▪ 3. 15-20 s phosphoric acid etching o The glass-ionomer part of an adhesive takes 24 h for settling.
Direct bonding	- = Bracket position is determined intraorally by the clinician. - Pro: Efficient for reposition of a single bracket, easier, faster, less expensive. - Contra: Not as accurate placement of the brackets, less opportunity for precise measurement of the bracket's position.
Indirect bonding	- = Placing the brackets on dental casts. Use a template / try to transfer the bracket positions to the patient. - Bonding material: o **Chemical cures resin:** - All brackets cure simultaneously. - Risk of excessive resin. o **No mix" chemical activated materials** (composite resin on the tooth surface in unpolymerized form, polymerization catalyst on the back of the brackets) - Excessive resin around the brackets' bases does not polymerize. - Bond failures ↑ (polymerization depends on diffusion). o **Flowable light-cured materials** with a transparent try - Polymerization takes more time than using a chemical cure. - The poorer the visibility in the mouth, the greater the indication for an indirect bonding approach. - Some companies provide transfer trays based on bracket's position determined from a digital tx simulation. → Ensures that the bracket's position will provide optimal alignment.
Debanding	- Bands are retained by the elasticity of the band material as it fits around the tooth. This is augmented by the cement, which seals the space between the band and the tooth. - No cement bonds strongly to the enamel. - If a band is distorted by force → Cement breaks away from the band or the tooth. No chance of damaging the enamel surface.
Debonding	- Failures at one of 3 interfaces while debonding a bracket: • Bonding material / bracket = usual failure site created by distortion of the bracket. • Bonding material itself • Bonding material and enamel surface → Undesirable, bonding material may tear the enamel surface. - Brackets removed without damage → Can be cleaned and reused. - Ceramic brackets: • Cannot be distorted → brackets break before they bend. • Chance of enamel surface damage, as the bond between the adhesive and a chemically treated bracket can be so strong that no failure occurs.
Prevalence of enamel decalcification	- Risk factors: o Young age at the beginning of tx. o Poor hygiene before tx start and during tx. - Some natural remineralization occurs → better prognosis if the surface is porous. Complete remineralization by themselves is not likely. - 0,05% sodium fluoride rinse is effective for prevention + fluoridated toothpaste. - Fluoride release from bonding agents happens only during a short time. - Fluoride release for 25 d from elastomeric modules that are changed at every appointment are maybe helpful.
Tx for white spots	- Natural remineralization for 6 months. - Avoid fluorides in high concentrations. (can arrest remineralization and lead to staining) - Better prognosis for active lesions with a dull, pitted and porous surface to regain normal enamel translucency than arrested lesions with a flat or shiny surface. - External bleaching for camouflage. - Acid microabrasion: Repeated application of a pumice-hydrochloride acid slurry. Cave: teeth may appear darker after tx due to enamel loose (rarely more than 250 microns). - Infiltration with ICON®. - Restorative tx with resin or porcelain veneers.

Bracket material	- <u>Production of steel edgewise bracket/tubes:</u> • Casting. (Bracket production by casting tends to increase nowadays) → Better precision of bracket slot size is achieved by milling the slot of a cast bracket) • Metal-injection molding (MIM). Major production of brackets. • Milling. • 3D printing: better slot precision. - <u>Titanium brackets:</u> • Nickel free → allergic potential ↓, biocompatible. • Bond reliability ↑ compared to SS brackets = less bond failures. (strength of titanium is similar to ss, but the stiffness only ½ → titanium has a higher resiliency | strength = stiffness x resiliency) • Surface chemical active and rougher: → Resistance to sliding ↑ (no problem if small wires are used). - <u>Stainless steel:</u> • Sign. nickel content 8%. → Mucosal allergic reaction to nickel are less prevalent than cutaneous reactions. Most patients with a skin reaction tolerate stainless steel orthodontic appliances. • Failure rate of ss brackets = ~3% *Optimal bond strength vs. material stiffness*  The graph illustrates the comparable bond strength with titanium and ss brackets and the lesser stiffness of a titanium bracket. This allow it to absorb more of an impact against the bracket and makes it more resistant to inadvertent debonding. - <u>Gold:</u> • Too expensive. • Bad performance. - <u>Nonmetallic appliance materials:</u> • **Plastic brackets:** ○ Staining / discoloration. ○ Poor strength: Brackets are likely to break when large wires are used. ○ Poor dimensional stability. → Not possible to provide precise bracket slots or build in all the straight-wire features. ○ High friction between the plastic brackets and the metal archwire. → Difficult to slide teeth in a new position. → Metal slots help to overcome some of the problems. → Useful only if complex tooth movements are not required. But: Composite plastic with better physical characteristics than steel exists. Engineering problems must be overcome to produce competitively priced brackets with better mechanical properties. • **Ceramic brackets**: ○ Produced from alumina as a **single-crystal** (provides great strength until the bracket's surface is scratched, smoother surface) or **polycrystalline unit** Pro: ○ Durable ○ Resist staining ○ Dimensionally stable

	Cave: ○ Fractures of brackets. Cracking of the bracket when torque forces are applied or brittle of bracket parts during wire changes or eating. ○ Friction within the bracket slot. ▪ Even with smoot surfaces of monocrystalline brackets. ▪ Possible chemical interaction between the wire and bracket material: → Metal slot was integrated overcome the problem. ▪ Nowadays the metal slot in most brackets is replaced by using corner-rounding and surface-smoothing techniques (limited evidence of the effectiveness). ○ Abrasion on teeth contacting a bracket: → Place ceramic brackets only in the mx arch. ○ Enamel damage at bracket removal. ○ Bulkier due to the smaller fracture toughness compared to steel. ○ Polycrystalline brackets: Relatively rough surface.
Straight wire concept in bracket / tube design	- Modern brackets are custom made for each tooth: → Minimizing the number of bends in the archwires necessary. - <u>Compensation for first order bends:</u> ○ Varying the bracket's thickness. ○ Offset position of the molar tubes: Flat molar surface would otherwise produce e mesiolingual rotation: ▪ 6+6, 7+7: Minimum 10° Offset ▪ 6-6: 5-7° (½ of 6+6) ▪ 7-7: Offset minimum as large as 6+6  - <u>Compensation for second order bends = artistic positioning bends:</u> ○ Built in tip (= inclination of the bracket slot) for maxillary incisors. Necessary because the long axis of these teeth is inclined in relation to the incisal edge.  ○ Distal tip of the upper first molar. Good occlusion cannot be achieved if the molar is positioned to upright even an apparent cl.I relation exists. 

- Compensation for third-order bends:
  - Cutting the bracket slot into the bracket at an angle or forming the base so that the face of the bracket is at an angle.
    = Placing torque in the bracket or into the base.
  - Torque is positive for incisors, negative for the molars.
    Influenced by:
    - Torque values chosen by the developer as the average normal.
    - Position of the bracket on the labial surface of the tooth.
    - Play in the bracket slot between the wire and the slot:
      → The expressed torque produced by undersized rectangular wires is far less than the bracket slot prescription might lead to expect.

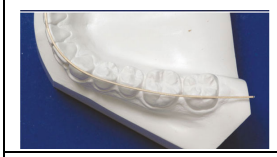
TABLE 10.3 Bracket/Tube Prescription: Incisors Through Premolars, Bracket Prescription

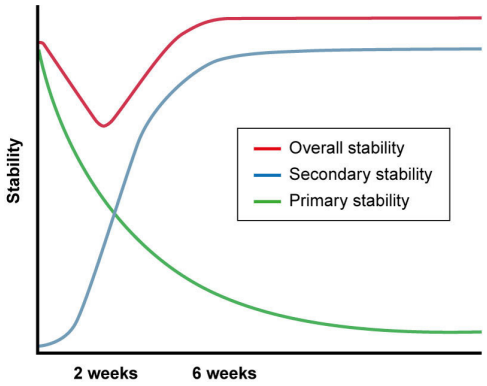
	CENTRAL		LATERAL		CANINE		FIRST PREMOLAR		SECOND PREMOLAR	
	Torque	Tip	Torque	Tip	Torque	Tip	Torque	Tip	Torque	Tip
Maxillary										
Alexander	15	5	9	9	−3	10	−6	0	−8	4
Andrews	7	5	3	9	−7	11	−7	2	−7	2
Damon (standard torque)	15	5	6	9	7	5	−11	2	−11	2
MBT	17	4	10	8	−7	8	−7	0	−7	0
Ricketts	22	0	14	8	7	5	0	0	0	0
Roth	12	5	8	9	−2	9	−7	0	−7	0
Mandibular										
Alexander	−5	2	5	6	−7	6	−7	0	−9	0
Andrews	−1	2	−1	2	−11	5	−17	2	−22	2
Damon (standard torque)	−3	2	−3	4	7	5	−12	4	−17	4
MBT	−6	0	−6	0	−6	3	−12	2	−17	2
Ricketts	0	0	0	0	7	5	0	0	0	0
Roth	0	0	0	0	−11	7	−17	0	−22	0

TABLE 10.4 Molar Tube/Bracket Prescriptions

	FIRST MOLAR			SECOND MOLAR		
	Torque	Tip	Rotation	Torque	Tip	Rotation
Maxillary						
Alexander	−10	0	13	−10	0	10
Andrews	−9	5	10	−9	0	10
Damon (standard torque)	−18	0	12	−27	0	6
MBT	−14	0	10	−14	0	10
Ricketts	0	0	0	0	0	0
Roth	−14	0	14	−14	0	14
Mandibular						
Alexander	−10	0	0	0	0	5
Andrews	−25	2	0	−30	0	0
Damon (standard torque)	−28	2	2	−10	0	5
MBT	−20	0	0	−10	0	0
Ricketts	0	0	0	0	0	0
Roth	−30	1	4	−30	0	4

Self-ligating brackets	- 3 types: o Springy clip: Innovation, Speed o Spring retaining clip in the bracket walls: Smart Clip o Rigid clip: Damon → All ligation types perform well and remarkably similarly. - *Burrow, 2009* o Friction: If Angle = 0°: ▪ Self-ligating bk < conventional bk ▪ Passive clip < active clip o Binding: Self-ligating bk = conventional bk o → Binding is mainly responsible for the resistance to sliding, = no difference conventional & self-ligating bk. - *Marshal, 2010*: Evidence concerning self-ligating brackets: o Saving of little time in ligating. o No saving of tx time. o No better tx results.
Individual customized brackets e.g. Insigna from Ormco	- Brackets fabricated by CAD/CAM. - Slot of each bracket has the appropriate thickness, inclination and torque needed for ideal positioning of a certain tooth. - Archwires with an arch form established for an individual patient are supplied. → Ultimate straight wire system. (some adjustments of the final archwires are still required) - Indirect bonding needed. - Cave: The focus is largely on dental intra-arch relationship and so every patient gets the same ideal incisor inclination without modifications which are necessary to facilitate the correction of the malocclusion. - *Brown, 2015:* Tx time and number of arches ↓ for individual customized brackets compared to directly or indirectly bonded brackets. The decrease was however attributed more to indirect bonding than customized brackets.
Lingual appliances	- Custom made precious metal pads with an attached low-profile bracket on the pad. - Wire bending eliminated by using wire-bending robots to form the archwires. - *Grauer, 2011*: Accuracy Incognito: Outcomes are quite accurate representations of the template, except 2nd molars. - *Knosel, 2014 / Pauls2017:* Win: o 3D printing for bracket production. o Tx time ↓ compared to Incognito. o Same accuracy like Incognito to achieve the planed outcomes.
Appliance choice based on a patient's preferences	- Major age and some minor gender differences: - <u>9-11y:</u> o Shaped brackets with/without colored elastomeric ties o Mini-twin brackets with colored elastomeric ties - <u>12-14y:</u> o Clear aligner (not practical with erupting teeth) o Esthetic brackets o Mini brackets with colored elastomeric ties - <u>15-17:</u> o Clear aligner o Esthetic brackets with a clear wire - <u>Adults:</u> o Lingual appliances o Clear aligner o Esthetic brackets with a clear wire
Archform selection for an individual patient	- NiTi / B-TMA: Impossible to shape the wires: → No choice than to use preformed arches. - Dimensions and the shape of the dental arches are correlated with the dimension and shape of the face. - The patient's original arch form should be preserved → teeth are placed in a position of maximum stability → less post-tx changes.

 	- Define the arch form desired at the end of tx already at the beginning. - Mn arch form should be used as a basic guide, if the mx and mn arch forms are incompatible at the beginning of tx. This is not valid, if the mn arch form is distorted e.g. from lingually displaced incisors. *Bennet, 2014* Situations when it is allowed to change the mn intercanine-dimension: o RPE in the mx: 3-3 are displaced by the narrow maxilla. o Cl.II:2: 3-3 are displaced by the maxilla. o 3-3 displaced by habits. o 3-3 are erupted lingually in a crowded situation. - Natural dental arch form = **catenary curve**: (Angle also defined a catenary curve) • Length of the chain and the width between the supports determine the precise shape of the curve. • Fits very well for the incisor-canine-premolar segment if fitted at the posterior width of the first molars. • Fit distal to the 1st molars is not good, because the dental arch curves slightly lingually in the second and third molar region. → Modifications necessary by the orthodontist. • Shape of most arches provided by contemporary manufactures. - **Brader arch:** • Archform based on a trifocal ellipse. • Round in the premolar-region and constricted posteriorly. • The archform is maybe more compatible with expansion therapy.
Wire bending robots E.g. Win (lingual) Sure Smile (buccal)	- Scan of the positioned brackets → robot shapes the archwire from a digital setup to the desired archform and adjusts it at each bracket. - Precise positioning of the brackets is not necessary, but the characteristics of the brackets must be known. - Initial leveling with light round wires is typical. - Evidence: *Alford 2014, Larson 2013* o Shorter time in fixed appliance. Cave: Less severe malocclusions were treated compared to the control patients in the study and less detailed finishing. o Lower scores for torque and tip compared to conventional finishing. o Final tooth positions are remarkably close to what has been prescribed. o Trend towards a lack of full expression of arch form and torque on 2nd molars.
Clear polymer archwires	- Pro: o Better esthetics. o Physical properties equal or better than metal archwires. - Contra: o Problems with wire stability. o Discolorations. - 2 types in development (not in clinical use so far): • <u>Formable:</u> o Approach from polyphenylene polymer. o Properties similar to small dimension beta-Ti wires. o Formability similar to stainless steel wires. • <u>Non-formable:</u> o Polymer resin matrix reinforced with glass fibers. o Auxiliaries like rotating wedges or bracket repositioning can be used to treat simple cases without customized wires. o Series of wires necessary for more complex cases. - Further research needed
Coated archwires	- White wires are rated as highly as clear wires by adults. - Coating is still problematic (easily lost).

Temporary anchorage devices	
Bone screws	- May place bends in the archwire to create root separation in the area where the screw is placed. - Screw material = titanium. - The screw location should be in the attached gingiva, not in the mucosa.  Clinical stability is the sum of primary and secondary stability. Note that clinical stability declines to a minimum at about 2 weeks post insertion, then (if all goes well) stabilizes at a somewhat larger value than the initial primary stability at about 6 weeks. - **Primary stability** is determined by *mechanical retention* of the screw in the bone. Depends on: ○ Bone properties ○ Engineering design of the screw ○ Placement technique - **Secondary stability** is defined by the *biologic union* of the screw to the surrounding bone. Determined by: ○ Implant surface ○ Bone characteristics ○ Bone turnover ○ Mechanic system used. ○ It's important to limit micro-movements which lead to bone resorptions and formation of a fibrous capsule. - The tension created by the srew insertion accelerates bone remodeling and screws become fitter → Load the screws early.
Factors related to stability / success of bone screws	- <u>Pitch of the screw threads:</u> **thight** vs. loose. ○ The denser the bone, the closer the threads should be. ○ Most of the screw's resistance comes from contact with cortical bone, little from medullary bone: → Tight pitch of the threads near the head of the screw gives greater contact with the cortical bone, higher pull-out strength, better primary stability. - <u>Length</u>: Usually **6-8 mm**. ○ Stability is mainly determined by the contact area of the screw with cortical bone (which is thin). → Longer screws should not perform better, but the amount of soft tissues overlying the bone must be taken into considerations. ○ Long screws which penetrate the cortical bone on both sides provide better stability, but are not worth the greater invasiveness. - <u>Diameter</u>: Usually **1.3-2.0 mm**. ○ Clearance is necessary between the root and the screw. ○ Root proximity is not a major factor in long-term stability. ○ If the alveolar bone screw is however < 0.5 mm away from the periodontal ligament, success rate sign. ↓ ○ Penetration of the periodontal ligament does not lead to ankylosis (cave: dog study). In humans, the possibility of ankylosis as the screw socket heals cannot be ruled out. ○ Success drops if diameter <1.3 mm (breakage). ○ Larger diameter provides better primary stability when heavy force is applied.

	- Form of the tip: **Thread-forming** vs. **thread-cutting** (cutting flute on the tip)
	  ○ Thread-forming screw:
	  ▪ Compression of the bone around the threads as the screw advances.
	  ▪ Better bone-to-screw contact.
	  ▪ Better adapted for use with alveolar bone.
	  ○ Flute on thread cutting screw:
	  ▪ Improve penetration into denser bone.
	  ▪ Better performance in the mn ramus / buccal shelf, zygomatic buttress and palate.
	
	- Surface of the threated part of the screw: Machined or roughed
	  ○ Roughed surfaces (sand blasted and/or acid etched) increase the primary stability and allow immediate loading.
	  ○ No major influence on the clinical stability.
	
	- Shape of the screw: Conical, cylindrical or mixed
	  ○ Thickness at the head: conical screws < cylindrical screws.
	  → Microdamage of conical screws to cortical bone ↓

Factors related to ease of use of bone screws	- Need for a pilot hole:
	  ○ Self-drilling screws do not need a pilot hole.
	  ○ Exception: If penetration of the cortical plate is difficult to prevent high insertion torque and potential screw fracture.
	
	- Need for soft tissue punch:
	  ○ Rarely needed in the gingiva (unless a pilot hole is to be drilled).
	  ○ Frequently needed in unattached tissues (mucosa).
	
	- Insertion torque and insertion device:
	  ○ Moderate insertion torque provides enough primary stability without causing excessive bone compression and subsequent remodeling.
	  ○ Torque control instruments for placing decrease the chance of screw fracture or overstressing the bone.
	
	- Type of anchorage:
	  ○ Direct:
	  Force is applied directly to a tooth or a group of teeth from a bone screw.
	  ○ Indirect:
	  Bone screw anchors a tooth or a group of teeth to which force is applied. Goal = prevent movement of the anchored teeth.

Design Factors for Bone Screws

Related to Stability and Success

- Pitch of screw threads: tight, not loose
- Length of screw
  - Alveolar bone, approximately 6mm
  - Palatal or mandibular bone, approximately 4mm
  - Base of zygomatic bone, 6 to 8mm
- Diameter of screw
  - Minimum 1.3mm
  - Maximum 2.0mm
- Shape of screw: conical preferred
- Form of tip: thread-cutting preferred
- Bicortical versus monocortical: monocortical preferred
  - Minimal stability advantage for bicortical
  - Decreased ease of use

Related to Ease of Use

- Pilot hole: better if not necessary
- Soft tissue punch: better if not necessary
- Insertion torque: better if low
- Insertion device: better if simple
- Direct versus indirect anchorage: both acceptable

Linked screws for palatal anchorage	- Palatal bone: Highest density anterior and lateral to the midline. - Linking 2 screws increases the resistance to force → neither screw can rotate.
Miniplates	- Placed on the base of the zygomatic arch. - Small connector extending into the mouth. - Ideal location for connector = junction fixed gingival tissue & loose mucosa. - Ideal number of screws = 3. → 3 screws = more stability than 2 screws, but not less than 4 screws. - Failures are for common for young patients: Bone maturity for good retention of the screws is not reached before 11 y. - More invasive than miniscrews. - Failure rate: **7-8%.** - <u>Procedure:</u> 1. Flap 2. Contour the miniplate to the bone surface: Contact at the pint of emergence to prevent excessive moments against the proximal screw. 3. Suture - <u>Advantages compared to single miniscrews:</u> • Larger amount of force tolerated: hold by 3 screws, thicker cortical bone. • The direction of pull can be changed. The source of force can be moved quite far by extending wire hooks from the intraoral fixtures. • Placed about the roots of teeth: → No barrier to move the teeth mesially or distally like interdental screws.

TABLE 10.6 Bone Screws Versus Miniplates

Single Alveolar Screws	Palatal Screws Linked by Plate	Maxillary or Mandibular Miniplates
Advantages		
Less invasive, lower cost	Excellent stability and resistance	Excellent stability and resistance
Orthodontist can place and remove	Orthodontist can place and remove	Can be placed above and below roots to allow en masse movement
Multiple sites for placement	Useful for vertical and anteroposterior movements	Useful for vertical and anteroposterior movements
		Easy to activate unilaterally
		well tolerated during therapy
Disadvantages		
Limited anchorage amount, move one or two teeth but not more	Framework in palate can be difficult for patient to tolerate	Experienced surgeon needed, not for typical orthodontist
No way to alter force direction without risk of losing screw	Bilateral screws needed	Surgery to place and remove
Vertical movement limited	Moderately difficult placement	Cost of surgery and device
Major Indications for Use		
Repositioning or rotating single teeth	Indirect anchorage primarily, for retracting protrusive incisors	Direct anchorage primarily, for retraction and/or intrusion of incisors
Bringing impacted canine(s) into the arch while preserving arch form	Indirect anchorage for intrusion of posterior teeth	Direct anchorage for intrusion of posterior teeth
	Indirect anchorage to bring posterior teeth forward	Direct anchorage for skeletal Class III growth modification

Proffit Chapter 11:

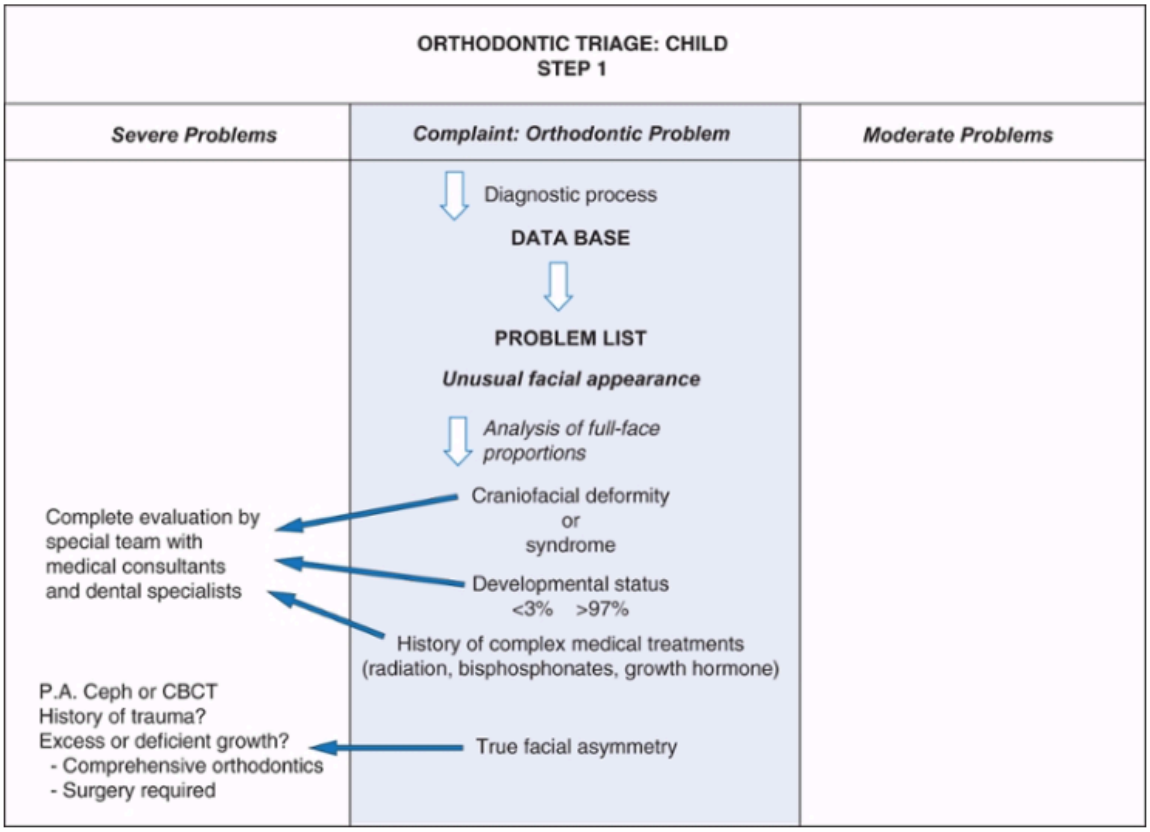
Moderate Nonskeletal Problems in Preadolescent Children:

Preventive and Interceptive Tx in Family Practice

Introduction: Tx in *preadolescent* children: What is different?	
Primary dentition	- Reasons against orthodontic tx: • Movement of primary incisors and canines is likely to lead to accelerated root resorption and premature loss of the primary teeth. • Movement of any primary tooth has little effect on where the permanent tooth will erupt. • Growth modification effects in young children are lost to a resumption of growth in the original pattern.
Mixed dentition:	- Focus on what "should be done". - Only obvious tx with effects that are known and proven is indicated. - Complex problems: High chance that a second stage of tx in the early permanent dentition is required. → Cave: Limit of time and cooperation from patients for orthodontic tx: • Patients can be burnt out by the time they are ready for comprehensive tx. • Chance of damaging the teeth / supporting structures increases with tx time. - Need of specific objectives, no need of comprehensive objectives. - Fewer tx options available. - Treat with a partial fixed appliance in a mixed dentition. - 2x4 / 2x6 arrangement: Long archwire spans → large moments are easily created, wires are springier and less strong → No use of superelastic wires with long unsupported spans. - Anchorage control more difficult and more critical. Implants are not possible: unerupted teeth, immature bone. - Unerupted teeth are at risk for resorption during tooth movement. E.g.: Movement of 2+2 → cave 3+3. - Make sure unerupted teeth are present. - Teeth without attachments tend to be displaced and squeezed out of the arch. - Sparingly use of interarch mechanics if no complete fixed appliance is present. Exception: crisscross elastics. - If early tx is carried out in only one dental arch, the final result is dictated by the untreated teeth / arch. → Difficult to obtain ideal occlusion & alignment. - Retention between the mixed dentition tx and eruption of permanent teeth is needed. - The final stage of transition is a particularly unstable time. o Wires through edentulous areas can interfere with the eruption of the permanent teeth. o Clasps on primary teeth are lost when the teeth are lost. o Higher hygiene risk and lower modifiability as teeth erupt with fixed retainers. o Overcorrection is maybe needed. (esp. for facemask or palatal expansion)
Summary prevalence malocclusions in the mixed dentition	- Posterior crossbite: **7.1%** - Anterior crossbite: **3.0%** - Anterior open bite: **< 4%** - Deep bite: **20%** - Ectopic eruption of mx canines: **1-2%** - Moderate anterior crowding 2-4mm: **25%** - Maxillary diastema: **25%** (Age 12-17: **7%**) - Transposition: **0.3%**

Orthodontic triage: Distinguishing moderate from complex treatment problems

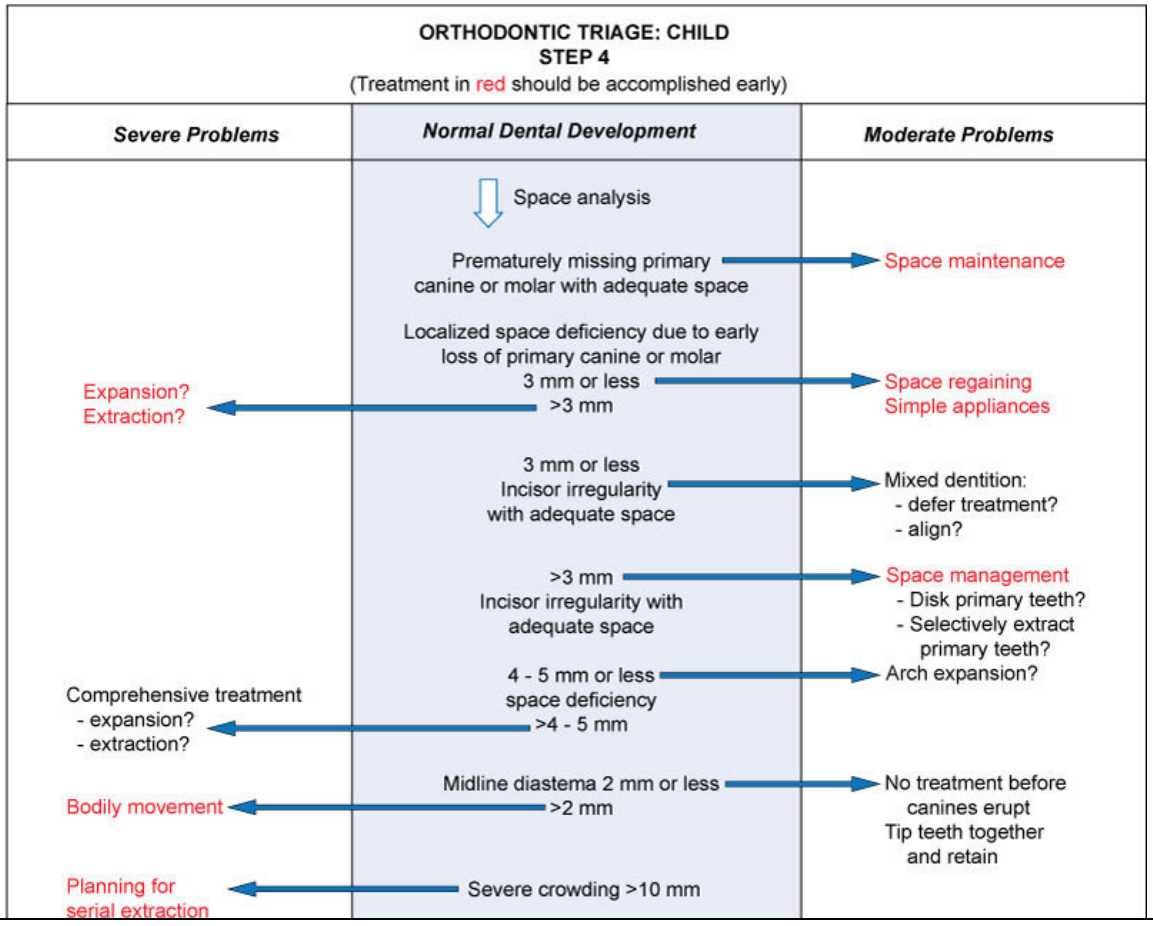
- Orthodontic problems are almost never an emergency.
- Adequate database + problemlist necessary for triage.
- Lateral ceph is not required → facial form analysis more appropriate in the generalist's office.



1. **Syndromes and developmental abnormalities**	- Easily to recognize by the physical appearance, medical / dental history, developmental status. - Complete evaluation by a special team with medical consultants and dental specialists. - Developmental status <3% or >97% requires special evaluation. - Significant skeletal asymmetries are always a severe problem. → Timing of the intervention depends on whether the cause of the asymmetry is deficient or excessive growth. - Growth disorders may demand that any orthodontic tx be carried out in conjunction with endocrine, nutritional or psychologic therapy. - Cave: Sign. skeletal asymmetry can also be caused only by a shift!
2. **Facial profile analysis**	- Early evaluation is indicated even if tx is deferred. - <u>Anterior-posterior problems:</u> • Class II tx can be deferred until near adolescence and be equally effective. ○ *Note*: Exception = Cl.II with lower lip interposition. • Class III tx for maxillary deficiencies should be addressed earlier. • Class III tx for protrusive mandibles: ○ Cl.III elastics during adolescence (less severe cases) or ○ Later orthognathic surgery - <u>Vertical problems</u> • Long face: ○ Can be delayed, growth persists until the late teens. ○ Condition can improve or become worse during the adolescent growth spurt. • Short face: ○ Can be delayed, managed well with comprehensive tx. ○ Exception: Early tx is indicated in case auf mx palatal gingiva damage.

	- <u>Asymmetry</u> • Early evaluation (a-p ceph, CBCT) is indicated even if tx is deferred. - <u>Excessive dental protrusion / retrusion:</u> • Urgency for tx depends on the esthetic impact & the potential for traumatic injury. • Incisor protrusion is often a compensation for crowding and an indication for premolar extractions.
3. **Dental development**	- Related problems often need tx as soon as they are discovered. - <u>Asymmetric dental development:</u> • In the absence of any pathology, often selective extraction of primary or permanent teeth needed. • Radiation therapy on the head / neck in childhood can cause root dilaceration. - <u>Missing permanent teeth</u> • Agenesis: most often 2+2, 5-5. • 21+12 = most likely to be lost in a trauma. • Maintenance of the primary tooth. → Anterior less an option due to enhanced esthetics. • Extract the overlaying primary tooth and allow the adjacent permanent teeth to drift. → Cave: Anterior edentulous ridges deteriorate quickly. • Extract the primary tooth following immediate orthodontic tx. • Replace the missing teeth prosthetically by transplantation or a later implant. *Note*: Timepoint for transplantation = 2/3 - 3/4 root formation. 80% success. • Ankylosed permanent teeth / PFE often require a combination of surgery (extraction or decoronation) and orthodontic tx. Tx options: o Ex + space closure / prosthetic replacement / transplantation o Luxation + traction o Surgical reposition o Segmentosteotomie / Distraction • *Oeschger et al.:* Influence of the craniofacial morphology. The location and the severity of the hypodontia define the severity of the impact. Mn plane angle ↓, ramus height, anterior & posterior face height, soft tissue convexity, measurements of upper and lower incisors. - <u>Supernumerary teeth:</u> • 90% in the anterior mx part. • Multiple supernumerary teeth can be an indicator for a syndrome or a congenital abnormality (e.g. cleidocranial dysplasia). • Early removal is indicated. • Single supernumerary teeth with *normal shape* often *erupt spontaneously* causing crowding problems. • Tubercle-shaped and *inverted* supernumerary teeth normally *do not erupt* spontaneously.
4. **Space problems**	- Protrusion accompanying a crowding is an indication that the natural limit of anterior displacement is already reached. - Correct handling of space deficiencies: Moderate crowding 2-4 mm = **25%** • <u>3 mm loss of space:</u> Space can be regained • <u>≤ 4 mm:</u> Labial reposition of incisors or space management during the transition phase. • <u>≥ 5 mm:</u> Mx anchorage or robust mechanics needed if non-ex tx. • <u>≥ 10 mm:</u> Spend attention, that permanent teeth are not impacted or deflected in their eruption path. - Diastema: **25%** • <2 mm will close spontaneously. • >2 mm, spontaneous closure unlikely, adjacent teeth can be inhibited to erupt properly

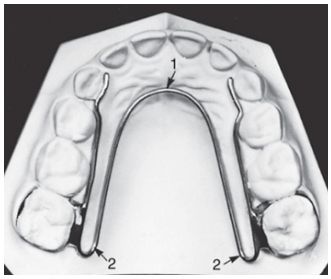
5. **Other occlusal discrepancies**	- Severity of CB, OB and open bite should be classified according to the facial form. - <u>Anterior CBs:</u> - Usually reflect a jaw discrepancy but can result only from lingual tipping of the incisors → tx fix or removable. - <u>Lateral crossbite:</u> **7%** • CB with a lateral shift form the initial dental contact position should be treated. • Tx of CBs without a shift should be delayed until the late mixed dentition: ○ If treated in adolescence, heavier forces and complex appliances will be probably required. ○ Early tx is maybe indicated if space in the arch is borderline. - <u>Excessive OJ:</u> **25%** Often reflects a skeletal problem. → Tx with removable appliances at any age. - <u>Anterior open bite:</u> **<4%** Good chance for spontaneous correction. - <u>Deep bite:</u> **20%** • Often caused or made worse by short anterior face height. • Seldom treated in the mixed dentition. - <u>Traumatically displaced erupted incisors:</u> • Often create an occlusal interference. • Risk of ankylosis. • Spontaneous re-eruption warranted if the apex is open and the root development incomplete. • Adults: ○ Intrusion < 4 mm: Short period of observations if re-eruption occurs. ○ Intrusion > 4 mm or no re-eruption after a smaller intrusion: Immediate orthodontic or surgical tx necessary.



Management of occlusal relationship problems: Posterior crossbite

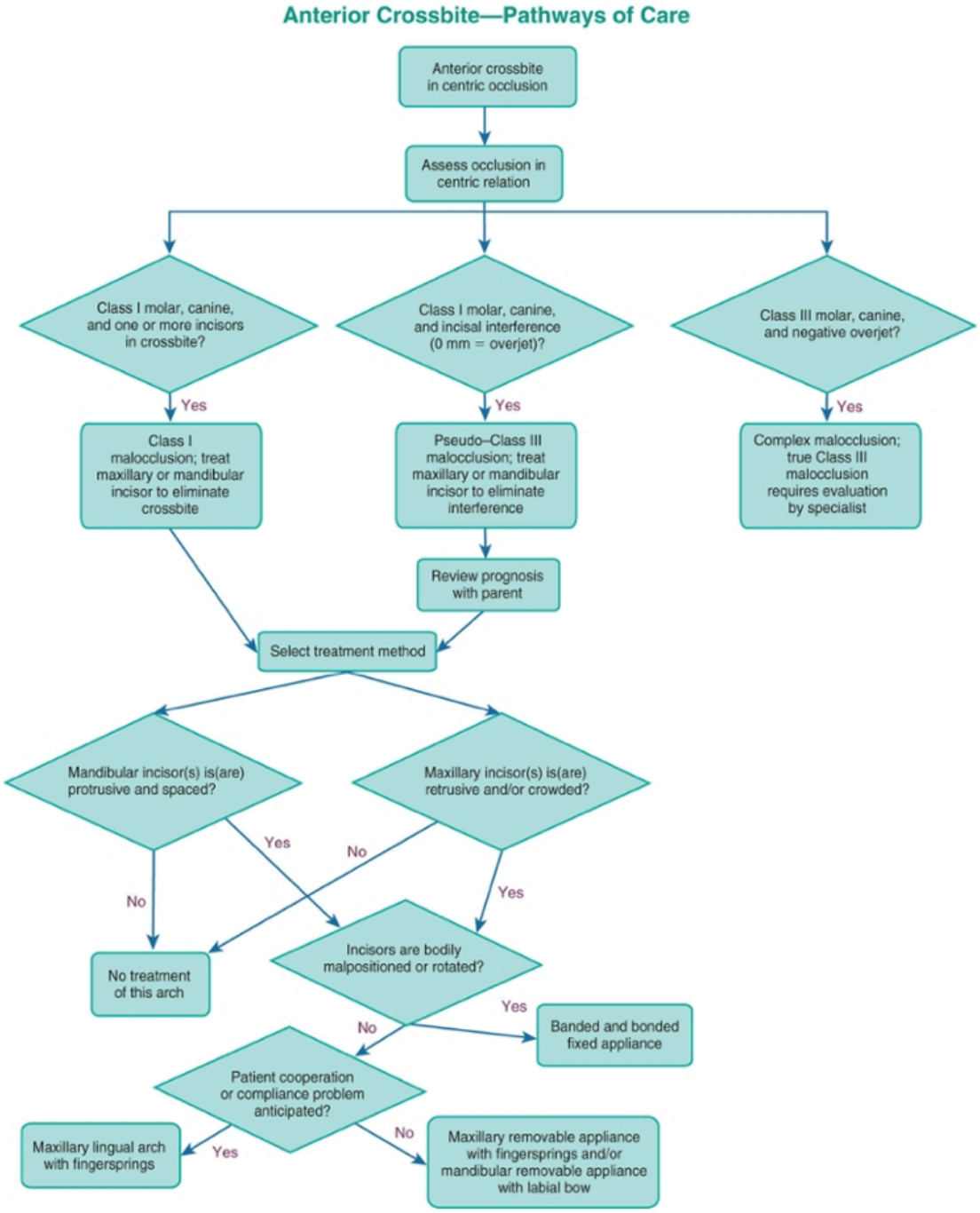
- **7.1%** of US children age 8-11y.
- Reasons:
    - Narrowing of the mx arch (prolonged sucking)
    - Lingual tipping of the mx teeth
    - Shift
- Shift / severe constrictions which reduce sign. the space within the arch → indication for early correction. Otherwise tx can be deferred.
- Differentiate if the mn asymmetry is the result of a shift of the lower jaw due to dental interferences or a true maxillary / mandibular asymmetry.
- Differentiate if the CB is related to skeletal maxillary retrusion or mandibular protrusion = relative mx deficit.
- **1 mm increase in the inter-premolar width → increase of arch perimeter values by 0.7 mm.**
- Total relapse after tx is unlikely in the absence of a skeletal problem.
- Heavy force and rapid expansion are not indicated in the primary or early mixed dentition.
  → Risk of distortion of the nose!

1. Equilibrium to eliminate a mandibular shift	- Occlusal interference for shifts is mostly caused by the primary canines or less frequently by the primary molars. - Position the mandible in CR → no CB. - Tx = reduction of the primary canines.

2.	**Expansion of a constricted maxillary arch**	- Expand to prevent a shift in CB if diagnosed. Exception if 6+6 are expected to erupt in less than 6 m→ wait to include them in the expansion device. - If the maxillary constriction is severe (mx teeth sit inside the mn teeth) and no shift exists → less reason to provide early tx, if it is not accompanied by severe crowding. - <u>Tx appliances:</u> • **Split plate**: relies on compliance, longer tx time, more expensive. → Not recommended. • **W- arch**: o Proper force level when opened 4-6 mm wider than the passive width. o Often teeth and maxilla move more on one side than on the other.  The W-arch appliance is ideal for bilateral maxillary expansion. (A) The appliance is fabricated from 36-mil wire and soldered to the bands. The lingual wire should contact the teeth involved in the crossbite and should not extend than 1 to 2 mm distal to the banded molars to eliminate soft tissue irritation. Activation at point 1 produces posterior expansion and activation at point 2 produces anterior expansion. The lingual wire should remain 1 to 1.5 mm away from the marginal gingiva and the palatal tissue. • **Quadhelix:** o More flexible & greater range of action than the W-arch. o 38 mil steel wire soldered to molar bands. o Bulky helices anterior help to remain stopping a finger in case of a sucking habit • **General rules for lingual arches:** o Lingual wire contacts the teeth involved in the CB 1-1.5 mm away from the marginal gingiva and the palatal tissue. o Activation for posterior or anterior expansion is possible. o Some opening of the midpalatal suture can be expected, not only dental expansion in a child with a primary or mixed dentition. o Skeletal change = ~50% of the total change o Effect: 2 mm expansion per month (1 mm per side) o CB should be overcorrected: Lingual cups of the maxillary teeth should occlude on the lingual inclines of the buccal cups of the mn molars. o IO adjustment is possible but may lead to unexpected changes. → Better appliance removal and recementation at each tx visit. o 3 m retention → correction seems to be stable in long term. o Imprint on the tongue possible: → disappears after removal of the appliance, but can last for up to 1 y.
3.	**Unilateral repositioning of teeth**	- <u>Tx if only the mx teeth need correction:</u> • Use different arm lengths of a W-arch or QH. Cave: Some bilateral expansion must be expected. • Mandibular lingual arch to stabilize the lower teeth + crisscross elastics to correct the mx teeth (more unilateral effect). Cave: Needs compliance. - <u>Tx if the mx and mn teeth need correction:</u> • Crisscross elastics. Cave: Extrusion possible. - Crossbites treated with elastics should be overcorrected and the attachments left in place after active tx. → Removal is possible when the occlusion is stable after a couple of weeks.

Management of occlusal relationship problems: Anterior crossbite

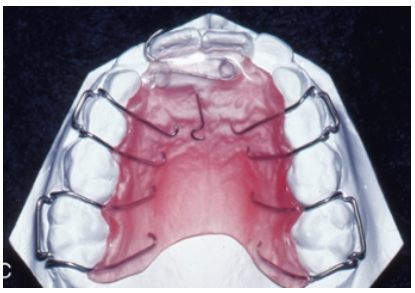
- Rarely found in children with no skel. cl.III jaw relationship.
- **3%** in the mixed dentition (mixed racial groups).
- In most patients due to lingually displaced mx central or lateral incisors:
  - Lingual position of developing tooth buds.
  - Teeth deflected to a lingual position by supernumerary anterior teeth / overretained primary incisors.
  - Lack of space for permanent incisors (most often).
- If discovered before complete eruption (no overbite), the adjacent primary teeth can be extracted to provide the necessary space.



1. Tx of nonskeletal anterior crossbite	- Develops typically with the eruption of the permanent incisors. - Origin of crossbite for isolated teeth: o Permanent incisor germs develop lingual of the primary teeth. o Eruption path of permanent incisors is deflected by space deficit / supernumerary teeth / trauma.

- Reasons to correct lingually positioned mx incisors / labial positioned mn incisors:
    - Limitation of lateral jaw movement.
    - Risk for sign. incisal abrasion.
    - Risk for gingival recession (esp. labial positioned mn incisors)

  Early correction is indicated.
  → But not in the primary dentition for most patients: rare event, incisors exfoliate before correction.
- Provide adequate space for spontaneous tooth movement:
    - Reducing the width of some teeth.
    - Extraction of adjacent primary teeth.
    - Opening space orthodontically.
- Most corrections are possible with tipping.
  Cave: If bodily movement is required, questionable stability is achieved with tipping.
- **Removable appliances with fingersprings or screws for facial movement of maxillary incisors:**
    - Labial bow is usually contraindicated, because it can interfere with facial movement of the incisors.
    - Reducing OB during CB correction is not necessary to prevent incisor interferences to achieve a correction with children, except if they are clenching / grinding or the OB is exceptionally severe.
      → Start with a removable appliance without bite plate and ad cement occlusal 6-6 if no correction is achieved after 2 m.
      Cave: Risk for elongation of posterior teeth, if the bite is opened.
    - Nearly fulltime wear necessary.
      Cave: Irregular wear time can jeopardize the result.
    - Perform a slight overcorrection.
    - May use a 22 mil double helix.
    - 2 months retention or until the OB is adequate to retain the incisors.

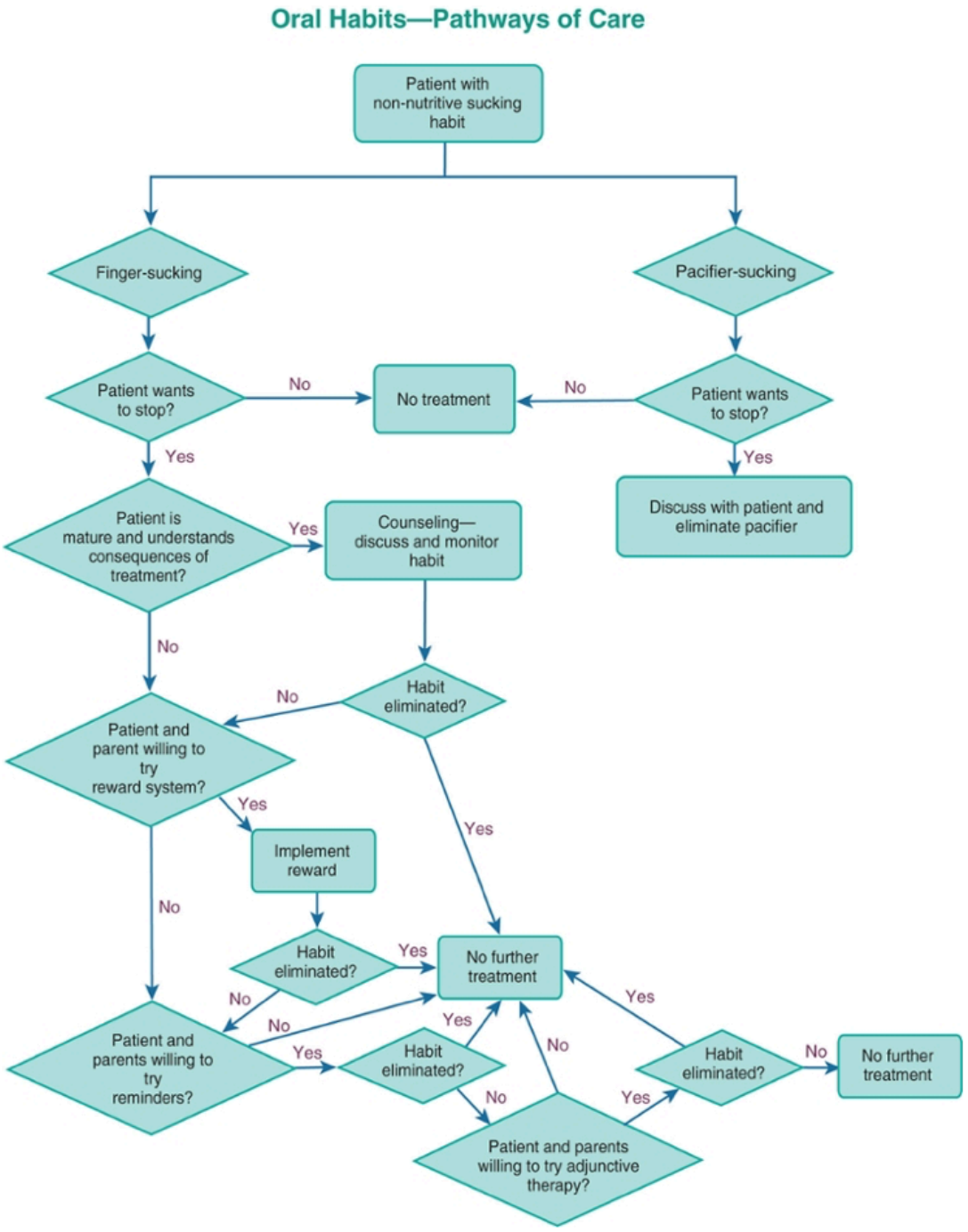


- **Maxillary lingual arch with fingersprings / whip springs**
    - Soldered on the opposite side of the arch from the tooth to be corrected to increase their length, ideal 15 mm.
      (gekreuzte Arme anterior)
    - A guide wire between the incisors can help to keep the springs from moving incisal.

- **2x4 fixed appliance**:
    - Best choice if crowding exists and need for rotations / bodily movement / more permanent teeth involved in CB.
    - Place brackets 2+2 with increased mesial root tip to prevent resorption by 3+3

- **Mandibular removable appliance with labial bow**

Management of occlusal relationship problems: Anterior open bite	
- **< 4%** in the mixed dentition: - Many of the transitional and habit related open bites resolve with time or cessation of sucking habit. - Open bites that persist until adolescence, except those related to habits, almost always have a significant skeletal component = complex open bites.	
Sucking habits:	- Effects depend on the frequency: o Mx incisors tip facially, mn incisors tip lingually. o Eruption of some incisors is impeded while elongation of the posterior teeth is allowed. o OJ increases. o OB decreases. o Mx intercanine and intermolar width is narrowed → posterior CB. Tongue is not placed in the palate → pressure from the check let the mx arch collapse) - Longer breastfeeding → fewer non-nutritive sucking habits. But: No difference in the long run in the prevalence of malocclusions between breastfed and non-breastfed children. - Pacifier shapes that are designed to produce a more physiologic sucking pattern have not been proven to be beneficial when compared to other pacifiers or to finger-sucking. - Some increased prevalence for a posterior CB for children with pacifier use compared to thumb-sucking. - Most of the sucking adaptions resolve spontaneously, except a posterior CB. - Tx is not indicated for children who don't want to quit sucking.
Nondental intervention:	- **Straightforward discussion** between the dentist and the child: Explain the problem. - **Reminder therapy**: Adhesive bandage with waterproof tape on the finger / anterior portion of the Quadhelix appliance. - **Reward system** for every day without sucking, big reward for total elimination. - **Elastic bandage** loosely wrapped around the elbow that prevents the arm from flexing
Appliance therapy:	- **Removable reminder:** Contraindicated if the nondental interventions were not successful. - **Maxillary lingual arch 38-40 mil with an anterior crib device** which interferes with the finger position during sucking for 6 m. - **Appliance to laterally expand** a constricted mx arch and retract flared and spaced incisors is maybe necessary.



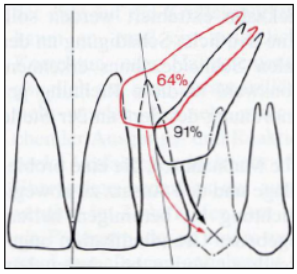
Management of occlusal relationship problems: Deep bite

- **20%** patients in the mixed dentition:
- Possible causes:
    - Reduced lower face height = skeletal problem. (not enough growth of the ramus)
    - Lack of eruption of the posterior teeth.
    - Overeruption of the anterior teeth.
- Addressed during comprehensive tx, unless there is tissue damage.

- Interim measure:
  Removable appliance with an anterior bite plane to encourage eruption of the posterior teeth and to protect the anterior tissue.

Management of eruption problems	
Over-retained primary teeth	- Extract if ¾ of the root of the permanent tooth is built. - Risk associated with over-retained primary teeth: o Gingival inflammation. o Hyperplasia → pain, bleeding. o Deflection of the eruption of the permanent tooth. - If a part of the permanent tooth crown is visible and the primary tooth moves 1 mm: → Encourage the child to wiggle → extraction if no exfoliation within a few days. - Roots of primary molars who hinder exfolitation: o Maxilla: buccal or lingual root. o Mandibula: mesial or distal root. - Removal of the retained primary tooth will allow some spontaneous alignment of moderately displaced facial or lingual positioned teeth, because of the equilibrium of soft tissue pressure.
Ectopic eruption of lateral incisors	- Ectopic = permanent tooth erupts on a different eruption path. → Emergence in the mouth at a different location than normally or sometimes totally blocked out. - Often associated with resorption of a primary tooth other than the one it is supposed to replace or resorption of an adjacent permanent tooth. - Some resorption of III+/- III is common when 2+/-2 erupt and indicates just a transitional crowding. - Loss of a primary canine indicates a significant lack of space for all permanent teeth: → Consider arch lengthening / expansion or later premolar extractions. - <u>Early loss of 1 mx primary canine:</u> o Immediate tx is almost required. - <u>Early loss of 1 mn primary canine:</u> o *Christenson, 2018 (data from the Iowa and Burlington growth study):* Prevalence of a clinical sign. midline shift is statistically not significant or greater than what was seen in patients with normal eruption: 1.3 mm and 1.0 mm rsp. o → Extraction of the contralateral canine to prevent a midline shift and stabilization with a lingual arch with a spur to prevent lingual tipping of the incisors is not necessary although thought so for a long time. - <u>Early loss of 2 mn primary canines:</u> Consider a passive lingual arch to prevent lingual tipping of the incisors and maintain adequate space if indicated.
Ectopic eruption of maxillary first molars	- <u>Resorption < 1-1.5 mm:</u> • Self-correction in $^{2}/_{3}$ of the cases. (**jumped teeth**) • Tx if eruption blockage lasts > 6 m or resorption continues. (**hold teeth**) - <u>Tx options to move the first molar away from the primary molar:</u> • **20/22 mil brass wire:** o Lopped and tightened around the contactpoint. o Tightened every 2nd week. o The patient must feel some discomfort to be sure that it is active enough. • **Steel spring clips separator:** Activated every 2nd w. • **Elastomeric separators:** o Large → force is needed to place it. o Potential to be displaced in an apical direction and cause periodontal irritation. • **Fixed appliance:** o Band on the primary molar with a soldered spring bonded to the permanent molar. o Band and loop spring fabricated intraorally. o 2 bonded brackets and a loop spring. - <u>If extraction of the primary molar is necessary:</u> The permanent molar must be guided during eruption, hold and repositioned distally after fully eruption.

<table>
<tr><td></td><td>    </td></tr>
<tr><td>Ectopic eruption of maxillary canines</td><td>- 1-2% of patients.
- Consequences:
• Impaction of the canine.
• Resorption of the permanent incisors 21+12.
Resorption is sign. more likely to occur, when no space is available for the canine.
- Genetic basis for the phenomenon probably.
- Sometimes related to small or missing maxillary lateral incisors / missing second premolars.
- CBCT is superior for the diagnosis of the location and the amount of resorption on adjacent teeth. Nevertheless, an OPG is recommended first to gain an overview and diagnose eventually other anomalies.

- <u>Mesial position of III+III with no root resorption 2+2:</u>
• Extract the primary canine: Ericson & Kurol, 1988
→ 91% normalization of the eruption path, if less than half of the root 2+2 is overlapped by the canine.
→ 64% normal eruption or improvement of the canine’s position, if more than half of the root 2+2 is overlapped by the canine.
 
• Good prognosis of spontaneous eruption, if the angle between the central incisor and the canine > 20°.

- <u>Criteria for successful eruption of ectopic canines:</u>
• Small dislocation vector.
• Prepubertal skeletal maturation
• Open apex

- <u>Therapy:</u>
• Ex primary canine → 60% spontaneous eruption (vs. 20% of controls)
• Ex primary canine +
▪ HG or
▪ RPE or
▪ TPE or
▪ RPE + HG = 80% spontaneous eruption.

- <u>If resorption on 21+12 is occurring:</u>
• Surgically exposure of the canine and alignment into position with orthodontic force and a bonded attachment.
• Looping a wire around the cervical part of the crown is no longer recommended:
More extensive bone removal, risk for ankylosis ↑, potentially reduced gingival attachment.
• Resorption produced by the canine will stop, but some resorption and blunting of the roots may continue.</td></tr>
</table>

Supernumerary teeth	- Mostly in the anterior part of the maxilla. - Supernumerary teeth erupt before or with the normal teeth, if they are not inverted. Inverted teeth do not erupt spontaneously. - Early extraction is indicated before problems arise: o Disruption of the eruption path of the normal teeth. o Crowding → arch distortion. o Spacing. o Displacement of other teeth. o Resorptions. → The earlier the extraction, the more likely that the normal teeth will erupt without further intervention. - Retain the tooth which is best in size, color, morphology and position related to the other teeth → CBCT may helpful. If all characteristics are equal, retain the tooth nearest to the ultimate final position. - Multiple supernumerary teeth can be an indicator for a syndrome or a congenital abnormality (e.g. cleidocranial dysplasia).
Delayed incisor eruption	- Often related to a retained primary tooth, a supernumerary tooth or some type of pathology. - Consider the morphology (usability) of the unerupted tooth and the likelihood to bring it into the arch (enough space must be available). - <u>Surgically uncovering:</u> • Superficial location: o Soft tissue excision. • Tooth more deeply positioned: o Reposition of the adjacent tissue apically to expose the crown. Cave: Risk of an uneven gingival margin. (will be overcome with further eruption of the incisors) o Surgical exposure and placement of a bonded attachment followed by fixed tx.
Ankylosed primary teeth	- Usually exfoliate when the permanent successor erupts without creating long-term problems. - Possible causes for retained primary teeth: • Delay of the eruption of the permanent tooth. • Deflection of the successor tooth from the normal eruption path. - <u>Tx if the permanent tooth is present:</u> • Maintain the primary tooth until an interference with eruption or drift of other teeth occur → then extract the primary tooth and place a lingual arch or a fixed appliance if needed to secure the space. • Adjacent tipped teeth most be repositioned. • Vertical bone discrepancies are corrected with the eruption of the permanent tooth. - <u>Tx if no permanent successor exists:</u> • Extract or decoronate (without root filling, but removal of the vital pulp tissue) the ankylosed tooth before a large vertical occlusal discrepancy develops. → It is possible that new bone will form coronal to the buried root structure and allow a later implant with good bony support. • Move teeth partially into the edentulous space to create new bone and then reposition them prior to implant or prosthetic replacement. → Space maintenance is contraindicated. • The longer the ankylosed primary tooth is left in place, the greater the chance of a long-term vertical bone defect + problems with reduced attachment and exposed cementum. (although extraction will also result in some loss of alveolar bone)

Management of space problems

Space analysis: Quantification for space problems

- Consider the space analysis in the context of the profile.
- Avoid expansion with limited OB.
  (facial tipping of the teeth moves them usually also vertical)
- Comparison between the amount of space available and the space required.
  Cave assumptions:
  - Anterior-posterior position of the incisors is correct.
  - The space available will not change because of growth and dental compensatory tipping.
    (true for most children if there is no jaw discrepancy exists)
  - All the teeth are present and reasonably normal in size.

- <u>Measure the arch perimeter:</u>
  - Divide the dental arch into segments that can be measured as straight-line approximations of the arch.
    Stöckli 1994: Space slightly underestimated.
  - Contouring a piece of wire → straightening it out for measurement.
    Stöckli 1994: Space slightly overestimated

- <u>Space required:</u>
  Measure the m-d width of each erupted tooth + estimate the size of unerupted permanent teeth.
  - Measurement of the teeth on x-rays:
    Cave: Distortion, radiation burden, compensation necessary for the enlargement. → Measure an object that can be seen on the x-ray and on the cast and the make a proportional calculation.
    OPG: Vertical distances can be measured and corrected by multiplying with the enlargement factor, but not horizontal distances.
  - Estimation from proportionality tables:
    Good correlation if applied to the population group from which they were developed.
    Exception: If obvious anomalies in tooth size or form are seen in the x-ray.

    Tanaka & Johnston 1974:
    Size prediction of the unerupted canines & premolars according the size of the lower incisors.
    Cave:
  - Caucasian females: mx + mn space overestimated.
  - African-American males: mn space underestimated.

  Proffit:

One half of the mesiodistal width of the four lower incisors	+10.5mm = estimated width of mandibular canine and premolars in one quadrant +11.0mm = estimated width of maxillary canine and premolars in one quadrant

Bernerskript:

$$\text{OK } \Sigma \varnothing 3\,4\,5 = \frac{\Sigma \varnothing \overline{2\,1|1\,2}}{2} + \boxed{10,5}^{*} \quad \begin{matrix} \♂ + \boxed{10,8}^{**} \\ \♀ + \boxed{10,2}^{**} \end{matrix}$$

$$\text{UK } \Sigma \varnothing 3\,4\,5 = \frac{\Sigma \varnothing \overline{2\,1|1\,2}}{2} + \boxed{10,0}^{*} \quad \begin{matrix} \♂ + \boxed{10,3}^{**} \\ \♀ + \boxed{9,4}^{**} \end{matrix}$$

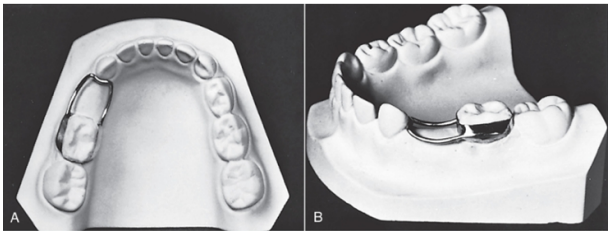
* durchschnittliche Summanden,
** geschlechtsspezifische Summanden aufgrund Untersuchung an Zürcher Kindern (Müller, H. J.: Med. Dissertation, Zürich 1976)

Space maintenance after premature tooth loss

- Space maintenance is only appropriate, when adequate space is available and all unerupted teeth are present with a normal stage of development.
- No space maintainer is needed, if a permanent successor will erupt within 6 m (½ - $^{2}/_{3}$ of the root formed).

1. Band-and-loop space maintainer

- = Unilateral fixed appliance in the posterior segment:
  - Band on the primary or permanent molar.
  - Loop contoured 1.5 mm of the alveolar ridge.
  - Soldered joints should fill the angle between the band and wire to avoid food and debris accumulation.
- Loop has limited strength:
  It holds the place, but it does not resist to functional forces of chewing.
- Mean survival time = 18 m.
- Recommended instead of a lingual arch, if a single primary molar has been lost bilaterally in young patients before eruption of the permanent incisors.
  → The permanent incisor tooth buds are lingual to the primary incisors and often erupt lingually.



- Bonding a more rigid wire about the edentulous space as alternative has not proved to be satisfactory.

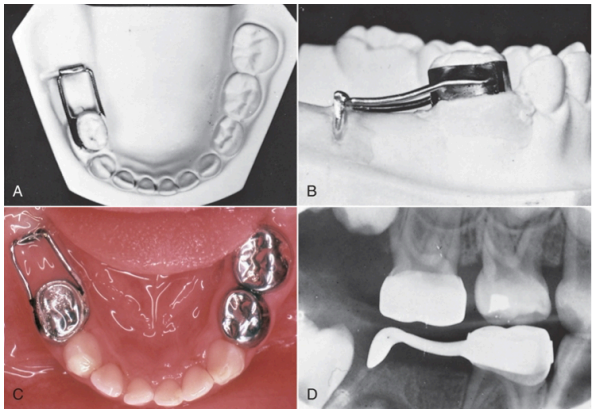
2. Partial denture space maintainers

- Indication:
  Bilateral posterior space maintenance when more than one tooth has been lost per segment and the permanent incisors are not erupted yet.
- Replacement of some occlusal function.
- Replacement of missing incisors.
- Frequent adjustments are necessary to prevent interferences with the physiologic adjustment of primary teeth during the eruption of the permanent teeth.

- Anterior space retention is unnecessary:
  - No arch circumference is lost, even if the teeth drift and redistribute the space.
  - Anterior teeth are not required for nutrition or speech development.
  - Children adapt easily.
  - Cave: Social disadvantages.

3. Distal shoe space maintainer

- Indication:
  Primary second molar lost before the eruption of the permanent molar.
- Metal or plastic guide plane extended into the alveolar process 1 mm below the mesial marginal ridge of the permanent first molar along the path they erupt.
- Occlusal x-ray + BWS to check the correct position.
- No functional replacement for the missing tooth.
- Tolerated well by children.
- Contraindicated for patients at risk for subacute bacterial endocarditis or immune-compromised patients.



4. Lingual arch space maintainers	- Indication: Multiple primary posterior teeth missing, permanent incisors have erupted. (Otherwise interferences are possible, because the tooth germs of the permanent incisors lay lingually of the mn incisors.) - Attached to bands or removable (more prone to breakage / loss). - 36 mil or 32x32 mil wire. - Adjustment loop mesial to the permanent first molars. - Rests on the cingulums of the incisors, 1-1.5 mm away from the soft tissue. - Lingual step in regio canines for the eruption of the permanent premolars / molars. - Survival time < 24 m, 25-30% failure.
5. Maxillary TPA (Gosh)	- Indication: One side of the arch is intact (for stabilization) and >1 tooth is missing on the other side. - Prevents a molar from mesial rotation if V+ or +V are lost and largely prevents mesial migration. - Several adjacent teeth should be present on at least one side of the arch when a transpalatal design is employed as a sole space maintainer to resist drift of the teeth. TPA = not strong enough if primary molars are lost bilaterally. - Bilateral mx tooth loss: **Nance lingual arch**. Cave: Soft tissue irritation.

Treatment of space problems	
Localized space loss ≤ 3 mm: space regaining **Maxillary space regaining**	- Space can be reestablished in a localized area with relatively simple appliances and a good prognosis. - Space regaining in the maxilla is easier than in the mandible: • Increased anchorage for a removable appliance by the palate. • Possibility to use EO force (HG). - **Distal tipping and derotation of the molars** (occurs spontaneously during distal tipping) to regain 2-3 mm space is satisfactory. - **Removable appliance with a helical fingerspring** adjacent to the tooth to be moved. Activation 1-2 mm/m → 1 mm tooth movement per month. - **Fixed appliance with a coil spring** for unilateral space regaining with bodily movement of the permanent first molar. A modified Nance arch is needed to support the forces.  - Regaining bilateral localized space loss of any amount is more complex.
Localized space loss ≤ 3 mm: space regaining **Mandibular space regaining**	- Removable appliances are difficult: o More fragile and prone to breakage o No palatal anchorage support o Tissue irritation o Poorer patient acceptance - <u>Unilateral mn space regaining:</u> Fixed appliance + maybe lingual arch for anchorage - <u>Bilateral loss of space due to lingual tipping of the incisors:</u> • **Lip bumper:** o Presseure against the lower lip → distal force to tip the molars in posterior direction without affecting the incisors. o Forward movement of the incisors due to removing any restraint from the lip (nearly equal to the molar change). → The equilibrium of the soft tissues is disrupted! o The arch is designed some mm facially advanced to the incisors. o Some transverse widening may also occurs depending on the type. • **Adjustable lingual arch:** o Posterior movement of the molars against the anchorage offered by the incisors. Cave: A sign. forward movement of the incisors must be expected. o Activation by opening the loop every 4-6 w. o Can be left in place as a passive retainer.
Mild-to-moderate crowding of incisors with adequate space	- ≦ 2 mm crowding in the primary dentition may resolve spontaneously in the transition to the mixed dentition. → No need for tx for mild incisor crowding during the mixed dentition except esthetics. → No increased long-term stability if tx takes place in the mixed dentition. - IPR of primary canines & molars. - <u>NO stripping of permanent teeth until all permanent teeth have erupted.</u>
Space deficiency largely due to allowance for molar shift - space management	- Little and easy tx if no other tx is required later. - <u>Moderate crowding with little or no space discrepancy:</u> o Lingual arch in the late mixed dentition just before the second primary molars exfoliate. o Disking primary posterior teeth to use the leeway space. - <u>Patients with overall adequate space but various amounts of transitional crowding:</u> (early loss of primary canines as the laterals incisors erupt) o A lingual arch should be inserted earlier to avoid distal movement of the incisors. → Some evidence for better long-term stability.

	- As soon as space is created by an active lingual arch or lipbumper, the incisors align spontaneously, if the irregularity is created by labial-lingual tipping. Exception: • No spontaneous correction in a straight anterior segment. • Rotations do not resolve → fixed appliance needed. - Molars are often retained in an end-to-end relationship when 6-6 are not allowed to shift into the leeway space → further correction needed.
Generalized moderate crowding 2-4 mm	- If an arch length discrepancy of 2-4 mm exists without prematurely missing primary teeth, moderate crowding of the incisors must be expected. - **25%** children of all ethnic group. - Only esthetic advantages for tx in the mixed dentition, better wait. - Long-term plan: • = Generalized arch expansion to align the teeth. • In case of excessively protrusive incisors: extractions.
Spaced and flared maxillary incisors	- Often in combination with some narrowing of the maxillary arch after a prolonged thumb-sucking habit. - Accompanying tongue thrust will disappear as soon as the teeth are retracted. - <u>If no contact between the upper and lower incisors exists:</u> • Retraction with a removable appliance and a labial bow 1 mm / m. • The plastic of the plate covering the lingual part to the incisors must be removed to provide space for posterior movement of the teeth and gingiva. - <u>Protruded incisors with deep bite:</u> Retraction is not possible without complex tx → better wait for later comprehensive tx.
Maxillary midline diastema	- Mixed dentition: **25%** - Age 12-17 y: **7%** - Ugly duckling stage corrects spontaneously with the eruption of the canines. - <u>Diastema ≤ 2 mm:</u> • Spontaneous closure possible. • Can be closed in the early dentition by tipping 1+1 together with a mx removable appliance with clasps, fingersprings and possibly an anterior bow. - <u>Diastema > 2 mm:</u> • Possible presence of a supernumerary teeth, intrabony lesions or agenesis 2+2. • Complete spontaneous closure is unlikely. • Not clear, if the soft tissue of the midline frenum attachment is responsible. →Try to move teeth and consider frenectomy only if excessive tissue is bunched up in the midline. Avoid early frenectomy.

Discussion 24.01.2017

- Teeth with an open apex are less prone to root resorptions due to orthodontic force application and other adverse effects (less resorptions by adjacent teeth).
- Bone follows tooth movement to 90% (e.g. extrusion).
- Extrusion:
  Gingival border and mucogingival border (this ø always) translate together with the tooth.
  = Correction of intrabony lessions is possible, but the attachment does not change.
- Best timepoint of posterior crossbite correction:
  - With shift: 9-10 y
  - Without shift: 10-11 y (just before fullfix or with fullfix tx if it is only a dental correction with the wire).
- An anterior crossbite can also be corrected by opening the bite with GIZ on the molars and just allow time for self-correction
- Sucking habit:
  - Instruct or order tongue trusting exercises when you fix a tongue crib although the swallow pattern normally adapts automatically.
- Delayed incisor eruption:
  - The standard deviation for the eruption timepoint has become larger in the last years.
- Ankylosed tooth:
  - If the permanent tooth is present and tipping of the adjacent teeth occurs, the baby tooth can be occlusal built up with resin.
  - If no permanent tooth is present, but space should be retained for later prosthetic replacement:
    1.) Decoronation
    2.) $Ca(OH)_2$ filling or only removal of the vital pulp tiusse without root filling
    3.) Palatal and gingival flap over the roots, suture
    → The roots are resorbed, but the bone is retained.
- Early failure of primary teeth:
  - No space maintainer is needed, if the root of the successor tooth is built up to ¾ (= eruption within 6 m) and the crown close to the marginal ridge.
- Frenectomy
  - First close the space → Evaluate if the soft tissue adapts → Plan frenectomy only later if it's still necessary.

Proffit Chapter 12:

Complex Nonskeletal Problems in Preadolescent Children:

Preventive and Interceptive Treatment

Eruption Problems	
Categories (*seminar ZMK*)	- **Delayed eruption** = Delay in eruption without etiologic cause. - **Embedded tooth** = Tooth ø erupted. - **Impaction** = Stop of eruption because of clinical or radiographic physical obstacle or an ectopic tooth position. - **Primary retention** = Tooth formed. ø eruption within 2.5 y of the mean value without visible eruption obstacles. - **Secondary retention** = Stop of eruption after emergence in the oral cavity without visible barrier or ectopic tooth position. - Ethiopathogenesis: • Ectopic toothbud position. • Obstacles in the eruption pathway. • Failures in the eruption mechanism: Follicle, PDL.
Delayed incisor eruption	- Make sure there is no impediment like a supernumerary tooth or a pathology. - Therapy: 1. Excision of the overlying soft tissues. 2. Bonded attachment if in doubt of the eruption potential. → Align the tooth with strain to the chain, NiTi overlay arch + heavy base wire and elastic chains.
Transposition	- = Positional interchange of two adjacent teeth. - **0.3%** of the population, M=F. - Most affected teeth: mn incisors & mx premolars. - Causes: • Ectopic eruption. • Genetic component. • Note: Probably associated with delayed primary tooth exfoliation. - <u>Transposition 2-2 with 3-3</u> • Cause: 2-2 erupt distally and lead to loss of IV III - III IV. • Need to position 2-2 mesially. → Bond the tooth or create surgical access to the tooth and apply traction to tip the tooth back (fixed appliance + lingual arch for anchorage). Simple tipping normally corrects the transposition and bodily movement of the tooth can be referred until later. • Cave: Potential risk for root resorption of 2-2 by 3-3. → Normally this does however not occur because the tooth germs 3-3 lie facially. → Begin tx before 3-3 are actively erupting to be sure. - <u>Transposition 3+3/4+4 or 3+3/2+2:</u> • Often the best approach is to move partially transposed teeth to a total transposed position or leave fully transposed teeth in that position.
PFE *Frazier-Bowers, 2007* (FB says PTH1R, ø PTHR1)	- = Failure of eruption without any overlying mechanical interference, because of a defect in the propulsive mechanism. - **Type 1:** Eruption failure occurred at or nearly the *same time* for all teeth in an affected quadrant → 2nd molar less erupted than 1st molar. - **Type 2:** A *gradient of time* of the failure was present, so that some further development of the teeth posterior to the most mesial affected tooth is observed before eruption failed → 1st molars = most severely affected

Type 1

Type 2

- <u>Normal cascade:</u>
  1. Parathyroid hormone receptor gene (PTHR1) is expressed on the surface of osteoblasts.
  2. PTH & PTHr (related protein) bind to PTHR1

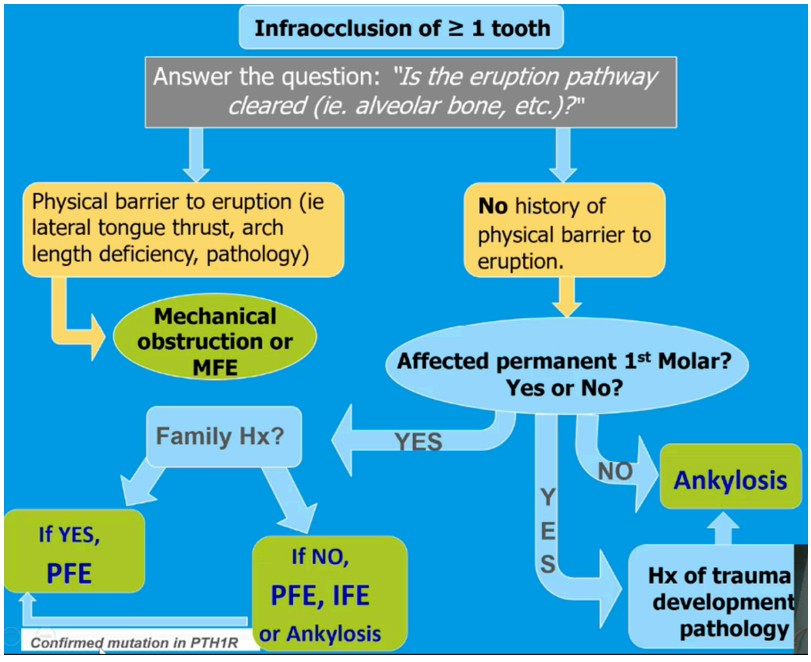
     PTHr is secreted during tooth movement from:
     - Adrenal gland ?
     - Fibroblasts
     - Rest of the Hertwig epithel board
     - Outer enamel epithel
  3. Osteoblasts release RANKL
  4. Activation of osteoclasts via RANKL/RANK System.

→ PFE: PTHR1 configurations changes → ø osteoclast activation.

- Release of RANKL:
  - Osteocytes via dendritische Fortsätze.
  - Osteoblastes: vascular.

- Genetic base: Heredity = autosomal dominant, heterozygote.
  - Multiple heterozygote mutations.
  - Does not jump generations.
  - 50% of descends are subjected to PFE.
  - Prevalence females = males (in some studies females > males)
  - Can be syndromic

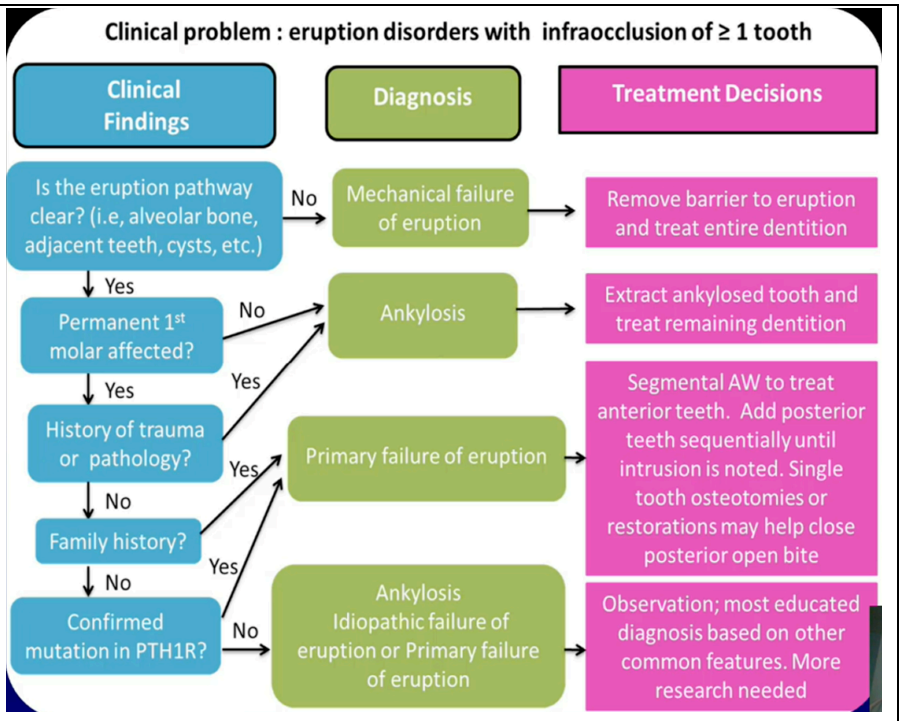
- Diagnosis:
  - Family history (genetic component) → check parents / siblings.
  - Genetics: Mutation of PTH1R.
  - Phenotype & Genotype correlation.
  - Predominantly posteriore teeth involved, including primary teeth.
    → Ankylosed primary molars could be an indicator of PFE.
    → Anterior teeth are not involved.
  - *1st molar* is always involved + all teeth distal of it.
  - Uncoupling of resorption and eruption is evident although a resorptive pathway is cleared. *ø mechanical obstruction*.
  - Teeth lay supracrestal ø coverd by bone.
  - Teeth do not respond to orthodontic force.
  - Uni- or bilateral.
  - Different quadrants can be affected differently.



- DD:
  - Mechanical failure of eruption.
  - Delayed eruption.
  - Anyklosis → teeth distal to the concerned move normally.
  - Early extraction of 1st molar → PFE if 2nd molar is also affected.
  - Start with a partial fix appliance an slowly extent it to the teeth with suspicion of PFE.

- Tx:
  1. Prosthetic replacement
  2. Premolar-occlusion in the affected quadrants
  3. Segmental osteotomies
  4. Distraction osteogenesis

PFE	Other Disorder
Affects posterior teeth only	Affects some or all anterior teeth also
Molars: always	Canines
Second premolars: sometimes	Lateral incisors
First premolars: rarely	Central incisors
Eruption pathway clear (no mechanical obstruction)	Mechanical obstruction of eruption (ankylosis, eruption pathway blocked)
Affected teeth do not respond to orthodontic force	Teeth respond normally after eruption path is cleared (ankylosis is permanent)
Family history (some, not all)	History of pathologic condition or trauma
PTHR1 mutation is diagnostic (but not all have this)	No or unknown genetic cause
The biggest diagnostic problem: One affected first molar (usually mandibular)—is it isolated ankylosis or PFE?	
• If it's PFE, the second molar also will be affected and will not erupt normally.	
• If it's isolated ankylosis, the second molar will erupt normally (including mesial drift).	
What do you do? *Extract the unerupted first molar as early as possible.*	
• If it was isolated ankylosis, the second molar will drift forward, bringing bone with it.	
• And if it was PFE, the second molar will be abnormal and also a candidate for extraction.	
Bottom line: You have nothing to lose with early extraction, and often something to gain.	

Impact of Radiation Therapy and Bisphosphonates	- High-dose chemotherapy / total body irradiation (esp. at age 3-5 y) →
	  ○ Short roots if teeth erupt
	  ○ Failure of the teeth to develop / erupt
	- Teeth can be moved with light forces and limited objectives without fear to lose them because of severe apical root resorption.
	- No orthodontic tx during bisphosphonates therapy.

Traumatic displacement of teeth www.dentaltraumaguide.org

- Teeth without irreparable damage should be repositioned with finger pressure to near normal position. (out of occlusal interference)
  → Stabilization for 3-5 weeks with a light wire or nylon filament.
  → If the alveolus has been fractured, stabilize teeth with a heavy wire for 6 w.
- Rule out vertical and horizontal fractures with x-rays.
- Start of orthodontic tx:
  - 3-4 m after trauma.
  - Wait longer after traumas with more severe periodontal injuries → up to 1 y: Luxation, intrusion, extrusion, avulsion.
  - Start earlier if a tooth creates an occlusal interference, but limit movement to a minimum initial.
- Higher risk for loss of vitality / root resorption for traumatized teeth when orthodontic forces are applied. Teeth with a partial obliteration of the pulp are at a particular risk.
- Follow trauma teeth clinically:
  - Mobility.
  - Sensitivity to percussion / cold / electric pulp testing.
  - Patients should report tooth discoloration, pain, swelling, discharge from the surrounding tissues.
- X-ray: Check for periapical pathology after
  - 2-3 w
  - 6-8 w
  - 1 y
  - *Von Arx*: Rx check after 3 / 6 / 12 months.
- Teeth with completed apex = more likely to become non-vital → pulpal extirpation and tx if it happens.

Vertical displacement of teeth:
 	
1. Intruded teeth
	- <u>Light intrusion</u>:
	  - Allow re-eruption 3 weeks before repositioning is considered.
	  - → Better probability if the apex is open.
	
	- <u>Severe Intrusion</u>:
	  - Surgical reposition or orthodontic tooth movement
	  - Indication for surgical reposition before healing of the trauma is complete:
	  ▪ Incomplete apex: intrusion > 7mm
	  ▪ Complete apex: intrusion > 3 mm
	  - Gingivectomy should be performed, if there is no access for surgical reposition.
	
	- Higher risk for pulp non-vitality after intrusion. → Endodontic tx if any signs of non-vitality (maybe orthodontic traction is necessary for access).
	- Risk of ankylosis ↑ after periodontal injury.

2. Extruded teeth	- If not immediately repositioned:
	→ Bone support ↓, poor crown-root relation → crown reduction indicated.
	- Orthodontic intrusion attempts result in bone defects between the teeth and increases the risk of loss of pulp vitality.
	- Avulsed teeth that were not completely seated in the socket during initial injury tx, can be successful orthodontically repositioned if tx start immediately.
	
	- <u>If the teeth cannot be restored:</u>
	  - Decoronation, removal of the clinical crown and root structure below the soft tissue level and removal of the vital pulp tissues.
	  - Wait until vertical growth is largely completed and an implant can be placed.
	  → Chance of alveolar ridge resorption ↓
	  → Need for later bone grafting ↓
	  - If the tooth is compromised, it can still be moved to bury the root at the ideal location.

- Endodontically treated teeth can be moved before or after the root filling without risk for root resorption.	

Space related problems

- Prevent molars / incisors from drifting after premature loss of primary teeth and reducing space for the unerupted teeth.
- No tx is indicated if the problem is too minor or later tx obviously needed.

Excess space

1. Spacing of permanent teeth

- Rare in the mixed dentition. Possible reasons:
  - Small-sized teeth in a normal arch.
  - Normal-sized teeth in large arches.
- Wait for the eruption of the remaining permanent teeth before space closure.
- No advantage of early tx, only esthetic.

- Large diastema which may inhibits the eruption of the adjacent teeth:
  - Bodily move 1+1 with an anterior segmental archwire and elastomeric chains. Easier if only m-d movement is required.
  - Retention is necessary at least until 3+3 erupt.
    - Bonded lingual retainer 1+1 if 32+23 are not erupted.
    - Removable plate if 2+2 are erupted.
      (allows adaptions of the roots 2+2)
  - Retention problems are mainly due to failure of gingival elastic fibers to cross the midline.
    May aggravation by a large or inferiorly attached labial frenum.
  - **Frenectomy**
    - Before tx = contraindicated:
      The potential contribution of the frenulum to a diastema is unclear.
    - Post tx only if unresolved bunching of tissue between the teeth makes it necessary.

2. Maxillary dental protrusion and spacing

- Tx is indicated only if the esthetic bothers or a risk of traumatic injury exists.

- Risk factors for dental trauma:
  - Protruding teeth
  - Increased OJ
  - Incomplete lip closure
  - History of previous dental injury in the primary dention or before age 9 y

→ Most injuries are minor (enamel and dentin chipping) and children do not benefit from early cl.II tx.
→ Limit orthodontic tx to retraction of protruded incisors and prescribe a mouth guard for sport activities.

- Tx if adequate vertical clearance and space within the arch exists:
  - Removable appliance: Tip incisors lingually.
  - Fixed appliance 2:4:
    - If bodily movement / correction of rotations is necessary.
    - Use closing loops or sections of elastomeric chains.
  - HG: Maybe necessary for supplemental anchorage support.

- Tx with deep OB:
  - Biteplate to allow eruption of posterior teeth to reduce the OB.
  - Mostly in combination with a class II malocclusion:
    → Complex tx that requires skeletal changes.

3. Missing second premolars

- Differentiate delayed forming vs. missing premolars!

- Tx options:
  - **Maintain primary 2nd molars** if the occlusion is acceptable.
    → Maybe some reduction of the m-d width is necessary to improve the interdigitation.
    → Cave: Risk of root resorption when they primary molar's root touch the roots of adjacent teeth.
  - **Extract the primary 2nd molar at age 7-9:**
    - Allow first molar to drift mesially.
    - May necessary to extract teeth in the opposing arch to reach an ideal class 1 occlusion and avoid unopposed antagonists.

	○ Cave: Great variation for the amount and direction of the mesial drift of the posterior teeth. • If only one primary molar is missing with no unilateral space loss or crowding on the contralateral side: → Prefer **restorative tx** instead of extraction. ○ Unilateral space closure in the mixed dentition is difficult without affecting the midline and other anterior interarch relationships. ○ Don't use TADs <12 y age. • **Gradually reduce the size of the primary tooth / hemisection** during comprehensive tx, to protract the permanent molars in the space without loss of alveolar bone.
4. Missing maxillary lateral incisors	- Long-term retention of II+II ≠ acceptable plan. - Eruption of 3+3 sometimes resorb II+II and replace them. → III+III are retained and lost only later, but do not persist until adulthood normally. - Eruption of 3+3 into the space of 2+2 is good to generate alveolar bone, no matter if a later space closure concept or prosthetic replacement is planned. - Later comprehensive tx is needed. - <u>Space closure:</u> • Close a large diastema if present to maximize the mesial drift of 3+3. • Extract III+III if they are not resorbed. → Premolars migrate into the canine position. • Best indication = with slightly protrusive incisors / tend. class II: → Reciprocal space closure is possible. • Avoid space closure with full class 1 or class III tendency or improve the situation with TADs. • Unilateral orthodontic space closure in the anterior region of the mouth is not recommended. → May extract contralateral incisors.
5. Auto-transplantation	- Indication: Missing tooth in one region and crowding in another. - Good prognosis if the transplantation is performed between $^{2}/_{3}$ - $^{3}/_{4}$ root formation. - 4-4 are best suited to replace 2+2 (root & crown form). - 3th molars are suitable to replace 1st molars. - Surgical intervention, 3 m healing, light orthodontic force to achieve final tooth position, restorative tx to recontour the crown. - High and predictable success rate.
Localized moderate-to-severe crowding > 3 mm	
Posterior quadrants	- Most likely the result of space loss or ectopic eruption. - Prevents eruption of succedaneous tooth. - Tx options: ○ If no comprehensive orthodontic tx is needed otherwise, it is sensible to extract the impacted tooth and close the space. ○ Unilateral space opening without disruption of the rest of the arch or the occlusion.
Midline shift	- <u>If no permanent teeth will be extracted:</u> → Midline correction before the eruption of the remaining permanent teeth to prevent an eruption in an asymmetric position and worsening of the crowding. - <u>Midline shift + inadequate space:</u> → Correct the problem before the eruption of the canines: Supportive lingual arch, bonding of the incisors, coil spring, disking or extraction of primary canines or molars.
III-III lost, 21-12 tipped lingually	- An active lingual arch can be indicated. - Tx is optional if the crowding is still severe after the incisors are repositioned and later comprehensive tx needed.
Generalized moderate and severe crowding	
- Expansion vs. extraction in the mixed dentition tx. - Symptoms of severe crowding in the early mixed dentition: ○ Severe irregularity of the erupting permanent incisors. ○ Early loss of primary canines caused by eruption of the permanent lateral incisors. - In case of severe crowding in the mixed dentition, expansion is not sufficient for correction and extractions should be considered.	

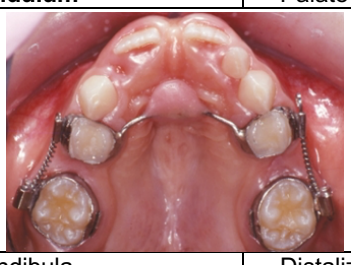
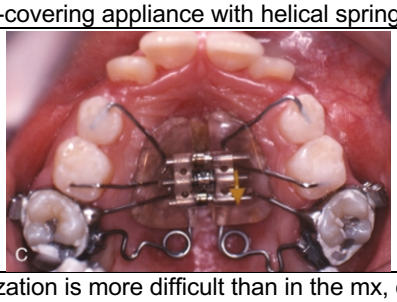
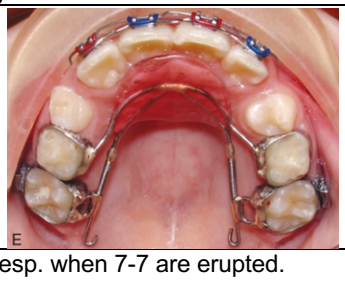
Expansion for tx of crowding in the early or late mixed dentition

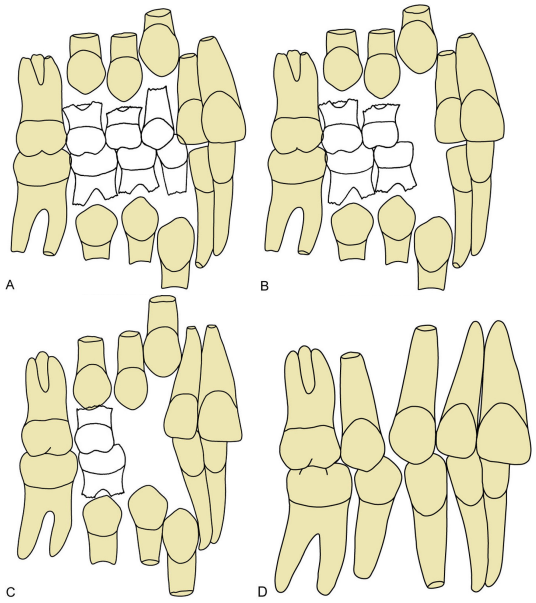
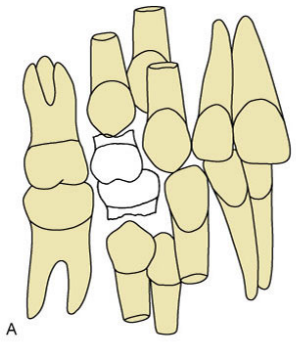
Indication	• Lower incisor position is normal or somewhat retrusive • Lips are normal or retrusive • OJ is adequate • OB is not excessive • Good keratinized tissue facial to the lower incisors - The indication for a prior gingival graft should be evaluated. → There is mixed evidence regarding the usefulness 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!

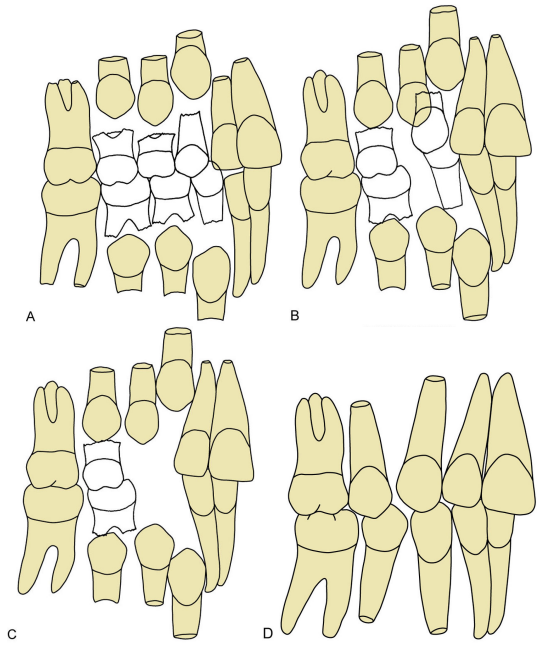
Expansion for crowding in the late mixed dentition: Molar distalization

- 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.	

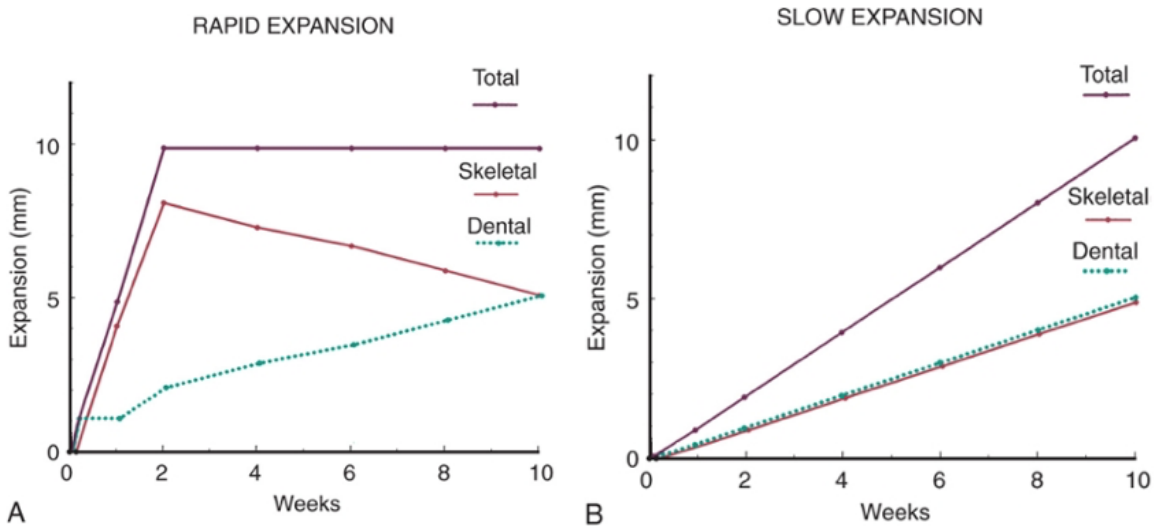
Proffit Chapter 13:

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.

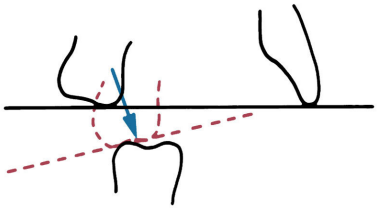
Restriction of excessive transverse growth	- Difficult but not impossible:
	  - Maxilla:
	  ○ TPA during growth maintains the molar width without affecting skeletal growth or the arch width at the canines / premolars.
	  - Mandible:
	  ○ Length of the lingual arch makes it flexible, so that some increase 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.

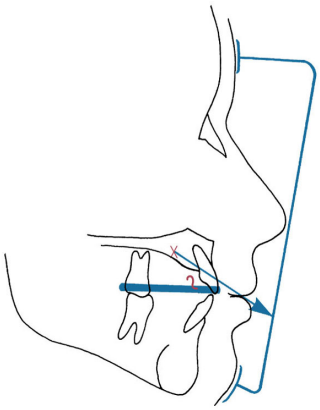
- *Wolfe 2011*: Characteristics of cll.III patients.
  - Mx: ø smaller, but more retrusive. Difference in size develops early.
  - Mn: Larger & protrusive → cumulative anterior-posterior growth.
  - Anterior face height ↑.
  - More hyperdivergent jaw orientation.
  - Cl.III pattern can be diagnosed before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

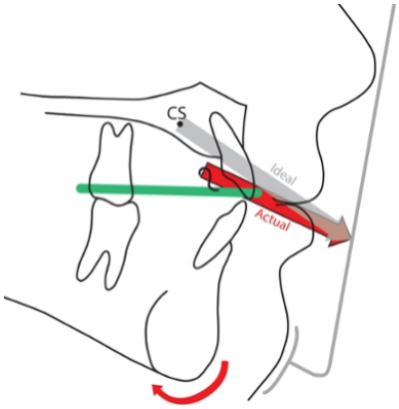
Anteroposterior and vertical maxillary deficiency

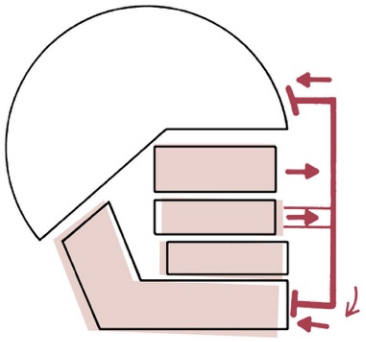
Direct effect	Maxilla is small or posteriorly positioned.
Indirect effect	Maxilla does not grow vertically → Mandible rotates upward and forward as it grows.
FR-III Functional Appliance (least effective tx approach)	- Effects: o The mandible is positioned posterior and rotated open. o Pads to stretch 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.







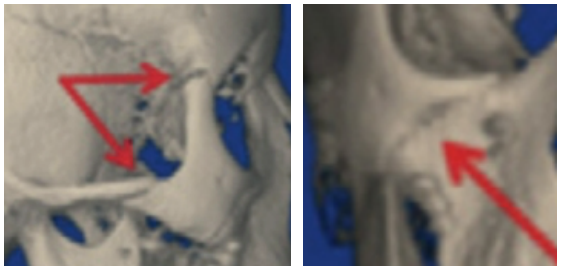
Forward traction against the maxilla typically has three effects:
(1) Some forward movement of the maxilla, the amount depending to a large extent on the patient's age.
(2) Forward movement of the maxillary teeth relative to the maxilla.
(3) Downward and backward rotation of the mandible because of the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

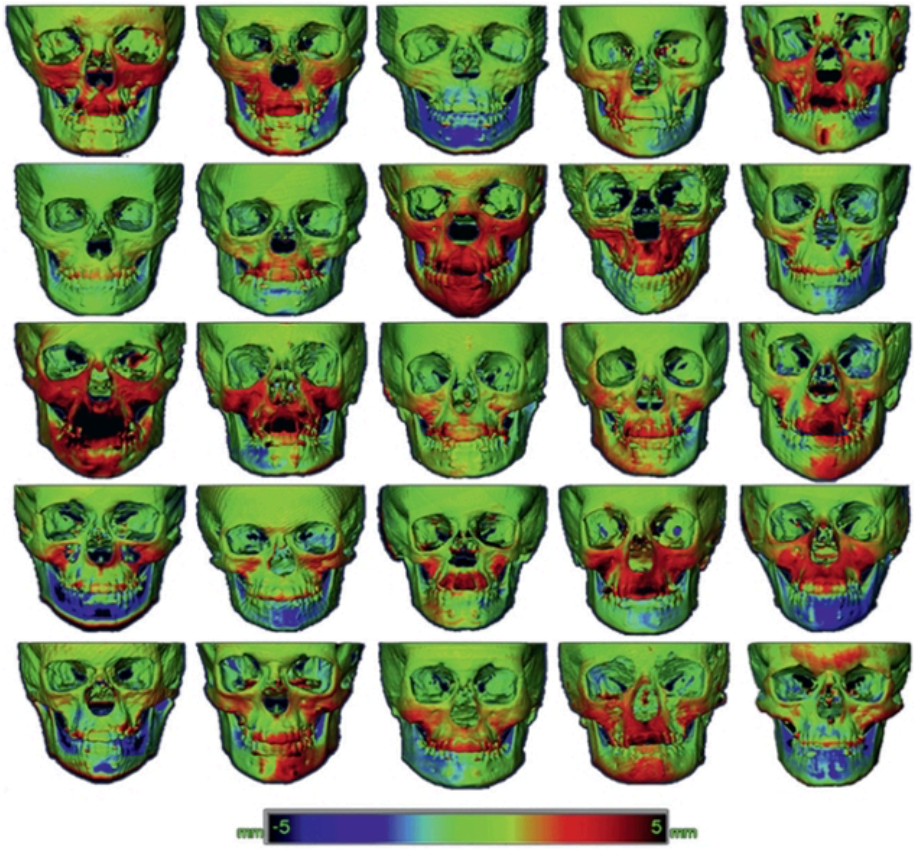
- <u>Alt-RAMEC:</u>
  - Mx mobility ↑
  - Compression of the facial sutures?
    Cave: **Gli1+** cells within the craniofacial sutures are critical for formation of all craniofacial bones and are activated during injury repair. Their loss is associated with craniosynostosis.
  - Only about 1 mm more 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

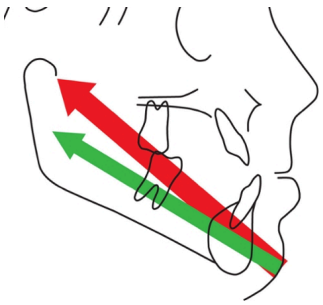
- Principle:
  - No restraint of the mn growth is possible.
  - Down-/backward rotation of the mn to guide the eruption of the teeth:
    Upper posterior teeth erupt down-/forward.
    The eruption of lower teeth is restrained.
    → Occlusal plane rotates in clockwise direction.
- Side effects:
  - 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.

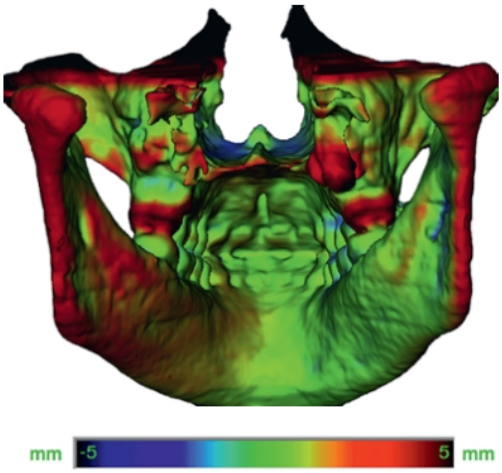
Cl.III elastic to skeletal anchors

- *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.

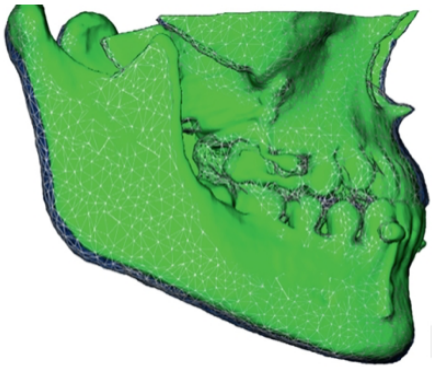
- Normally the point of articulation of the mn with the temporal bone does grown straight downwards in relation to the cranial base:
  → Lengthening of the mn results in chin projection.
- Sometimes the direction of growth has a backward component → compensates for growth in cl.III patients.

- 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.

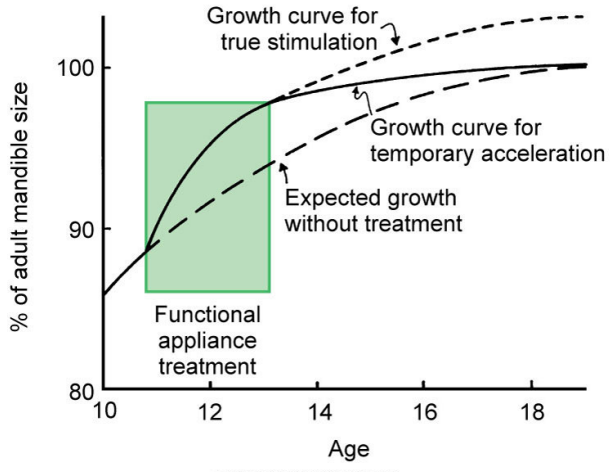


This detailed superimposition of the mandibular change in a typical patient is still another unexpected finding: what amounts to a bending of the mandible at the gonial angle, so the chin is not projected forward as much as it would have been if the inclination of the ramus to the mandibular body had 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:

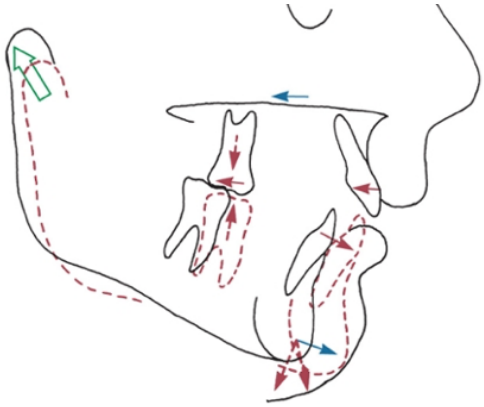
Growth Modification in Class II, Open Bite / Deep Bite and Multidimensional Problems

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.

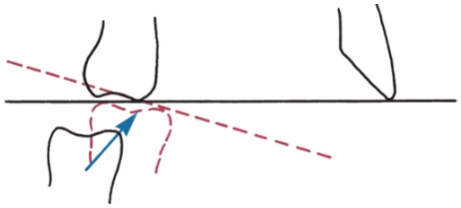
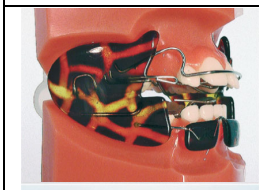


- HG effect is observed in most functional appliance tx that position the mn anterior. This is presumably because the soft tissues are stretched when the mn is advanced and this force is transferred to the mx.
- Extreme lingual tipping of the mx incisors during functional appliance tx usually reflects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

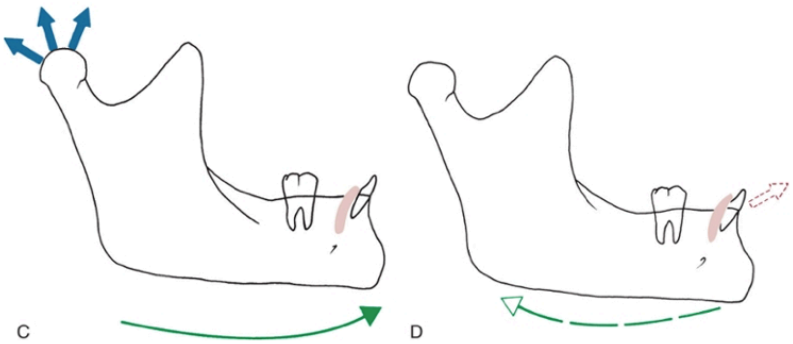
Fixed cl.II correctors	
Fixed cl.II correctors	- Most fixed functionals appliances tip teeth and have dentoalveolar effects when used in adolescents. The amount of tipping depends on which anterior and posterior teeth are included in the anchorage units through supplementary bonding or banding. - Protrusive effect on the mn dentition, because the appliance contacts the lower incisors and some of the protraction force is transmitted to them. → Can be reduced by skeletal anchorage (which does not affect skeletal changes). - Low prevalence of TMJ dysfunction which is similar to removable appliances. (poorly documented)
1. Herbst appliance	- Created by *Herbst* in the early *1900s* and reported on it in 1930. - Rediscovered and popularized by *Pancherz 1970.* - Dental and skeletal effect. - Use in the early permanent dentition (not in the mixed dentition). - Can produce maxillary posterior dental intrusion: → Ideally used in patients with normal or slightly long anterior face height.
2. MARA	- Developed by *Toll and Eckhart in the 1990.* - Upper elbow interferes with the lower fixed arm → patient must advance the mandible in order to close the mouth. - HG effect + effect on the mandible (less than a Herbst appliance). - Preferred by patients in comparison to Herbst.
3. Forsus **4. Cemented Twin-Block**	- Upper distal and intrusive moments + lower mesial dental movements. 
Literature	- *Tarvade, 2014.* Fixed Twin-Block vs. Forsus: o More positive mn changes for Twin-Block. o Forsus: More vertical skeletal and dental changes. - *Guintini, 2015.* Fixed Twin-Block vs. Forsus: o Forsus: More positive mn change, mx restriction ↑, mn incisor proclination ↑. - *Siara-Old, 2012.* MARA-appliance vs. Twin-Block: o MARA: mx restriction ↑, mn advancement ↓ in short term.
Class II elastics	- Effects: Mx dental retraction, mn dental protrusion. - More mesial displacement of the mn teeth than stimulation of mandibular growth. → Cave: Protruding incisors tend to upright after tx → crowding. - Minimum **250 gm** force needed to shift one dental arch relative to the other with a square wire. Less force is needed with a ligher, rounder wire in the mandible.

Components of removable and fixed cl.II appliances

- The appliance design has a great influence on the effects to the teeth.
- Active components:
  - Patient has to voluntarily move the mn by use of the musculature to avoid an interference. → Produces external pressure.
  - Activator, bionator, Twin-Block, MARA
- Passive components:
  - Only a restricted path of movement or closure is allowed.
  - Herbst, Forsus.

1. To advance the mandible

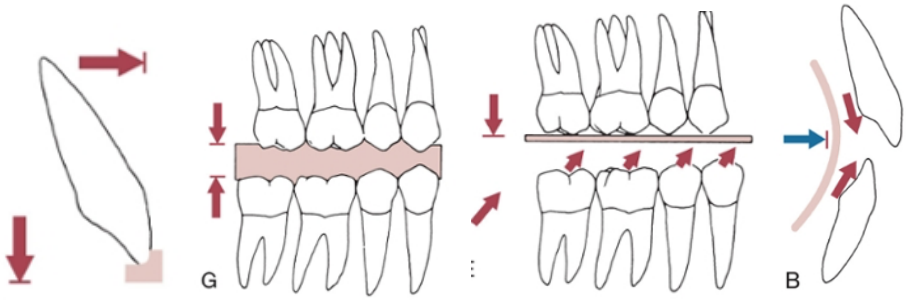
- **Flanges**:
  - Against the mn alveolar mucosa / Below the mn molars / **Lingual pads** contacting the tissue behind the lower incisors (Fränkel)
  - Stimulus to posture the mandible to a more anterior position.
- **Ramps** supported by teeth (Twin-Block)
- **Elbows** (MARA)
- Cave: Compensatory movement of the molars and incisors from forward posturing the mn! → Try to minimize them by adapting how and where the forces are applied.



2. Vertical control components

- Acrylic / wires are placed in contact with the teeth → the vertical dimension is opened → stretch of tissues exerts an intrusive force on the teeth. Normal eruption is impeded, but no intrusion occurs (probably because the force is not constant).

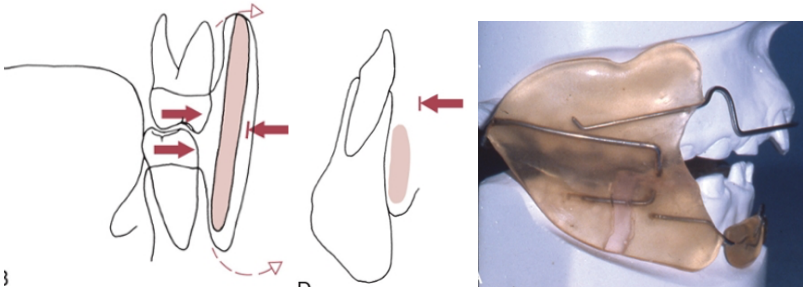
- Occlusal or incisal stops incl. **bite blocks**:
  - Incisal stop can extent to the facial surface and control the anteroposterior incisor position.



- **Lingual shields** (B)
  - Prevents the tongue to be placed between the teeth → enhancement of tooth eruption.
  - Cave: Speaking is difficult.

3. Stabilizing components

- **Clasps**:
  - Help at the beginning to adapt to the appliance.
  - Can be removed or deactivated when the patient has learnt to use the appliance.
- **Labial bow**:
  - Use recommended in almost all instances to put the appliance in proper position, not to tip the upper incisors lingually.

	○ → Bow does not touch the incisors when the appliance is put in place, but nevertheless often contacts them when the appliance moves or is displaced. ○ → Extreme lingual tipping of the upper incisors during functional appliance tx usually reflects a failure of the child to keep the mandible positioned forward while wearing the appliance.
4. Passive components	- **Plastic buccal shields** and **lips pads**: (Fränkel) ○ Hold the soft tissues away from the teeth. ▪ Disrupt the tongue-lip-equilibrium. ▪ Facial movement of the teeth, arch expansion, increase in arch length. ▪ Environment is likely to revert to what it was previously when the appliance is removed. ○ Force of the lip to stretch helps to improve lip seal. ○ Potential for soft tissue irritations → can reduce compliance. ○ Shields extended to the depth of the vestibule have potential for periosteal stretching which facilitates bone deposition. 
5. Active expansion / alignment components	- Correction of the occlusal relationship by actively moving teeth is not the original goal of functional appliance. - **Springs / screws**: ○ Produce only tipping, no precise tooth movements are possible. → Tipping is more susceptible to relapse. - Tooth movement ↑ → potential to achieve skeletal changes ↓

Treatment procedures with functional appliances and clinical management	
Pretreatment alignment	- Necessary for cl.II:2 or crowded upper incisors. - More efficiently performed with a partial fixed appliance than a removable appliance. - Several months of retentions necessary after repositioning.
Impression and working bite for functional appliances	- Don't overextend the impression so that tissues are displaced if buccal shields or lip pads are planned. - For cemented, bonded or partial fixed appliances only the impression of the teeth is important, but not the vestibule. - Small and big advancements are similar effective, but smaller advancements are more comfortable. - Working bite: o Advance the mandible to move the condyles out of the fossa and establish the desired vertical opening. o Symmetric advancement if no asymmetry has to be corrected. o **4-6 mm advancement**. o <u>Normal face height patients:</u> ▪ **3-4 mm vertical opening**. ▪ Interocclusal stops or facets to guide eruption usually require 4-5 mm of posterior separation to be effective. o <u>Long-face patient:</u> ▪ Vertical opening 2-3 mm past the resting vertical dimension = **5-6 mm total opening in the molar region**. → The soft tissue stretch against the bite blocks will produce a force opposing eruption of lower posterior teeth. o Avoid edge-to-edge incisor relationship. o Avoid interferences from retromolar soft tissues.
Clinical management of removable functional appliances	- Begin: Wear the appliance only a short timer per day and then increase the time gradually over the first few weeks up to 12h/d. - Wear the appliance 8 p.m. - 1 a.m.: → Time period when growth and tooth eruption are occurring. - If a sore spot develops, wear the appliance 2 days more for some hours. → Source of the sore can be accurately determined. - Give a chart: = Data record & reinforcement to wear the appliance. Cave: Time reported by patients and actual compliance often do not coincide. - Records + minimum a laterals ceph after 8-10 m to reevaluate the progress. Because initial advancement is only 4-6 mm, many children need a new / modified appliance.
Clinical management of fixed functional appliances	- Fixed functional appliances: • Often create initially problems with the forward position of the mn. • Accommodation increases rapidly after several days. • Sore teeth for an extended moment indicate poor cooperation: The appliance should only remind, but not force the mandible to be put forward without heavy force. • Avoid hard & sticky food, large mouthfuls and exaggerated mn movements. • 1-2 mm relapse must be anticipated. • Records after the appliance is removed. • Removable retention device in case the patient is still in the mixed dentition after removal of the appliance. - Herbst: o **8-12 m** in situ - Forsus: o Arches should be coordinated sagittal and transversal to avoid interferences. o 19x25 mil SS wire secured with wire tied under the archwire or a chinch-back to consolidate the arch length and avoid space opening. o Ideal activation: 2 mm space between the completely compressed spring and the pushrod stop when the patient is in CR. o The appliance can run form 6+6 to the distal aspect of 3-3 or 4-4 (vertical, intrusive component ↑). o May apply lingual torque to avoid incisor proclination. o 6-8 m in situ followed by 4-6 w with the spring in a passive state.
Clinical management of extraoral force: HG	- Effect: • Decrease of the amount of forward and/or downward growth of the maxilla by changing the pattern of apposition of bone at the sutures.

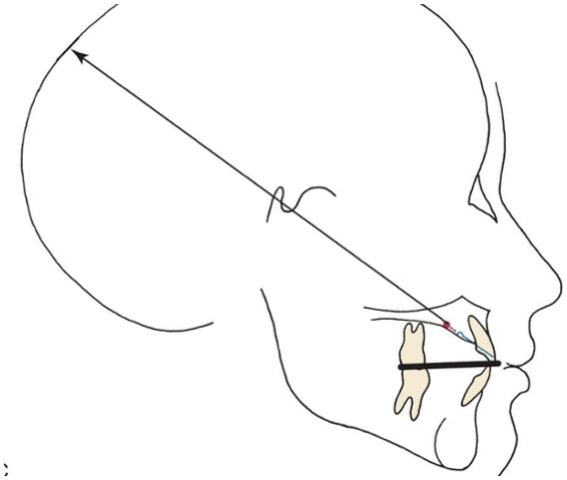
- Evidence for increased mn growth during HG tx (*Keeling, 1998*).

- Clinic:
  - Weartime = 10-12h/d, best time period = evening.
  - **350-450 g/side** depending if skeletal or dental effects are desired.
    - Lighter forces: May produce only dental effects.
    - Forces > 1000 gm: Unnecessary traumatic to the teeth and supporting structures.

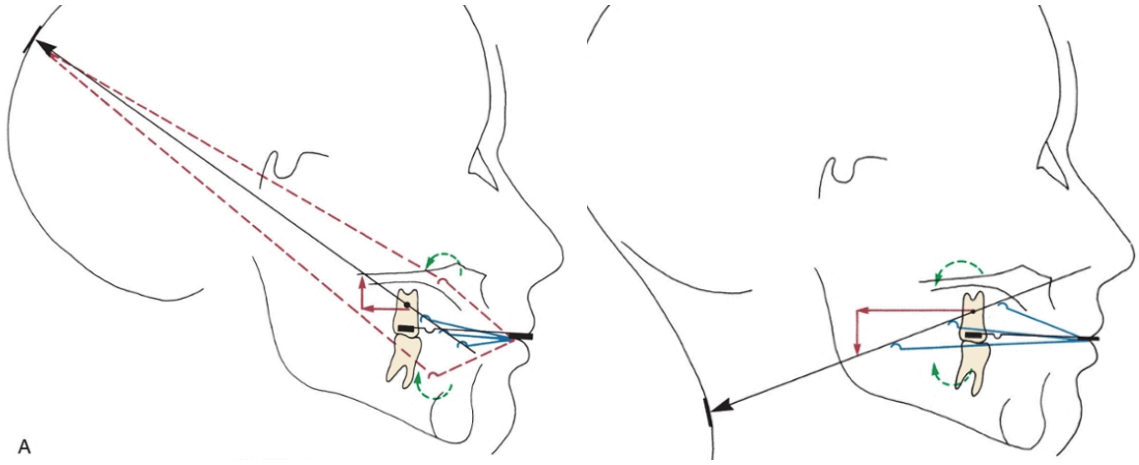
  - Factors influencing the selection of the HG:
    - Anchorage location
      - Determine the vertical force component.
      - → The more signs of an excessive vertical growth pattern exist, the higher the direction of the pull should be chosen.
      - *Haralabakis, 2004*:
        Cervical HG does not always aggravate vertical problems, esp. when the vertical mn growth is good.
    - Attachment of the HG to the teeth:
      - Facebow inserted into HG tubes on bands 6+6
      - Mx splint
      - Functional appliance
    - Bodily movement vs. tipping required?:
      The length and position of the outer bow and the anchorage form define the vector of the force and its relation to the center of resistance 6+6.
      → Orientate the vector of force in relation to the **center of resistance of the molar (midroot region)** to adapt the effect.

  - Avoid distal tipping and elongation of the molars if a change of the skeletal relationship is desired. Downward mx movement or mx and mn molar eruption can reduce or totally negate forward growth of the mn.
    (this would project mn growth more vertically)
    → Highpull HG is usually preferred.

  - **Center of resistance of the maxilla = above premolar apexes**:
    - Mx rotation is possible, if the line of force does not run through the center of resistance.
    - High pull HG directs the force closer through the center of resistance.
    - HG to a mx splint covering all teeth makes it easier to control the rotation of the mx.
  - With all the teeth splinted, the maxilla can be considered as an unit and the line of force related to the center of maxilla.
    → Distal tipping of the mx incisors is likely to occur also when a skeletal effect is the goal, because the distal component of the force is delivered to these teeth.



- HG adaption:
  - Expand the inner bow 2 mm to prevent CB during Cl.II correction. (inserted in one tube, it should rest just outside the other tube)
  - No contact of the inner bow with the teeth (3-4 mm distance).
  - Inner bow ends flush with the end of the tube.
  - Junction of the inner and outer bows rests passively between the lips.
  - Outer bow rests several mm away from the soft tissue of the cheek.
  - Determine the proper length of the outer bow by simulating the direction of force with the fingers from anterior to posterior.
    → If the bow does not move = force through the center of resistance.
    - **A longer outer bow bent up or a shorter outer bow bend down could produce the same line of force.**
    - **The outer facebow of a cervical HG is nearly always longer than the outer bow used with a highpull HG.**
  - Chose a spring mechanism, no elastic bands for consistent forces.



- Php HG: A longer outer bow bent up or a shorter bent down could produce the same line of force.
- Plp HG: A longer outer bow bent down or a shorter bent up could produce the same line of force. The outer bow of a cervical HG is nearly always longer than the outer bow used with php HG.

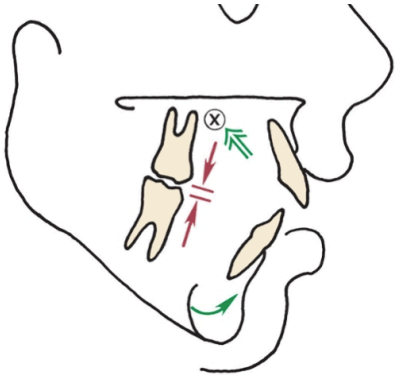
Combined vertical and anteroposterior problems	
Vertical problems	- Skeletal vertical problems are connected with excessive or deficient dental eruption and it can be difficult to determine the extent to which skeletal disproportions vs. tooth eruption deviations are involved. - Consider: The mn grows downward from the mx and the teeth must erupt to remain in contact. → **Patients with deficient vertical growth also have deficient tooth eruption and vice versa.** - **The vertical position of the mx posterior teeth determines the vertical position of the mn**: Excessive eruption → mn rotates downward and backward.
Short face / deep bite	
Characteristics of short face individuums	- Skeletal vertical deficiency occurs almost always in conjunction with an anterior deep bite and some mn deficiency / often Cl.II:2. - The reduced face height is often accompanied by everted and prominent lips that would be normal with normal face height. - Characteristics: o Children can be determined at an early age. o Low mn plane angle (skeletal deep bite). o Long mn ramus. (*Note*: does not make sense, if a vertical deficit exists) o Growth is expressed in an anterior direction with a tendency towards upward and forward rotation of the mn.
Tx goals	- Increase the eruption of the posterior teeth. - Influence the mn to rotate downward without decreasing chin prominence too much.
Appliances	- <u>Tx options if cl.II:</u> o Cervical HG → Extrusive tendency for the mx and mx teeth. Cave: Risk to rotate the occlusal plane posterior down → cl.II ↑. - <u>Tx options if cl.I:</u> o Mn teeth are allowed to erupt, eruption of mx teeth is inhibited. → Functional appliance (not fixed in the mixed dentition short face tx) that inhibits eruption of mx teeth and allow free eruptions of mb posterior teeth. o → Eruption is faster in some patients than others. Affected by the resting mn posture, the freeway space the appliance wear-time. - Cave: Many short face patients also have a cl.II occlusion. → Rotation of the occlusal plane downward in the front makes it easier to achieve a cl.I occlusion. Greater eruption of mx teeth, rotates however the occlusal plan posterior down = accentuation the cl.II occlusion. → In severe cl.II patients, may correct first he anteroposterior relation before you begin grinding the appliance for molar eruption.

Long face / open bite

- Excessive mx growth in children with a cl.II malocclusion has more of a vertical than an anteroposterior component:
  Mx moves down → downward + backward rotation of the mn = mn growth is not expressed in anterior direction
- In many preadolescence patients, open bite tendency reduces without tx. In others, the open bite tendency persists.
- Vertical facial growth continues into the post adolescent years:
  → Long active retention necessary.
  → Tx approach only for minor-to-moderate problems and plan the intervention towards the end of growth period.

Tx goal:

- Control the posterior mx vertical growth, so that the mn can rotate in an upward and forward direction.
- Control all tooth eruptions if there is adequate mn vertical ramus growth.



Tx options:

- Tx options in order of increasing clinical effectiveness:

1. <u>High-Pull HG to the molars:</u>
   - Control the vertical position of the maxilla and inhibit the eruption of the maxillary posterior teeth.
   - Cave: Does not control the eruption of the lower molars which can outstrip changes made by controlling the upper molars with a HG.

2. <u>High-Pull HG to a maxillary splint</u>
   - Vertical force directed against all mx posterior teeth or extended forward to include also the anterior teeth.
   - Useful for children with excessive vertical development of the entire mx arch and too much exposure of the mx incisors from beneath the lips.
   - Cave: Mn posterior teeth can erupt freely → may no direction of growth, nor favorable upward & forward rotation of the mandible.

3. <u>Functional appliance with bite blocks</u>
   - Slight HG-effect. The eruption of the posterior teeth and the vertical descent of the maxilla are inhibited, with / without anterior positioning of the mandible.
   - Open the bite past the normal resting vertical dimension:
     (5-6 total opening in the molar region)
     → Stretch of the soft tissues → vertical intrusive force on the posterior teeth.
   - Anterior teeth can erupt in children with an anterior open bite.
   - Mn growth is projected anteriorly.
   - Cave:
     - Retention is necessary during later tx.
       (bone screws, bite plates)
     - Later fixed appliances do not well control eruption and are in many actions extrusive.

4. <u>High pull HG to a functional appliance with bite blocks</u>
   - Addition of an HG provides little if any more vertical skeletal and dental control and only a modest anterior-posterior maximum

	skeletal impact → Benefit should be weighed against a simpler functional appliance without HG. ○ *Freeman, 2007*: The skeletal impact of a HG-functional appliance stage (when treated later with fixed appliances) is so little, that it can no longer be recommended. 5. <u>Intrusion of posterior teeth with skeletal anchorage / mx segmental osteotomy</u>

Facial asymmetry in children

Epidemiology of facial asymmetries	- Severe asymmetric development which causes problems is rare: **0.5%** US population. - Asymmetric problems involving only the mx are rare and most likely due to trauma. - Asymmetries involving only the nose are more common and are often also due to trauma. - The mn is involved in 85-90% of the facial asymmetry cases, because of growth problems → secondary effect on the mx → mx & mn are both likely to be involved if an asymmetry develops.
Asymmetric mandibular deficiency	- Possible causes for an asymmetry: o Congenital anomalies (hemimandibular microsomia): o Likely to be noticed at birth. o Involves also the ear. o Growth modification is only effective for the least affected patients. o Fracture of the condylar process (often not reported): o The later the asymmetries arise: → Likelihood that origin is a fracture ↑. o Most of the time not diagnosed when they happen.
- Treatment of condylus fractures	- Maintain the function: Translation is necessary for regeneration. → Stretch of the associated soft tissues in the short term. → Allowance of normal growth in the long term. → Control not only the maximum mouth opening. - Most fractures in preadolescent children can be treated without surgical manipulation of the segments and little immobilization of the jaws. The bony segments are self-retentive. Rapid healing process. - Tx approach: 1. Short fixation time (IO intermaxillary elastics). Avoid open reduction of the fracture (risk for scarring). 2. Rapid return to function. 3. Functional appliance during post-injury period to minimize any growth restriction. - The extension to which the affected side can translate establishes the prognosis for growth modifications in case of an asymmetry. - Hybrid functional appliances can be useful to achieve more growth on the fracture side.
- Surgical therapy of mn asymmetric deficiencies	- Surgical interventions prior to adolescence are indicated only to create an environment in which growth is possible. → Indicated only when abnormal growth is progressively making a problem worse (e.g. ankylosis). - Functional hybrid appliances are needed after the surgical intervention has made condylar translation possible to correct the primary growth problem, decompensate the dental arches vertically and guide function.
Asymmetric mandibular excess	- Excessive mn growth on one side = hemimandibular hypertrophy. - Females more affected than males. - Progressive deformity. - Growth modification to stop excessive growth is not possible. - Early surgery is maybe necessary.

Discussion 21.2.2017

- Start of class II functional therapy: Shortly before the growth spurt and with the growth spurt.
- Define the growth spurt.
  - Gender
  - Age
  - Secondary sexual characteristics

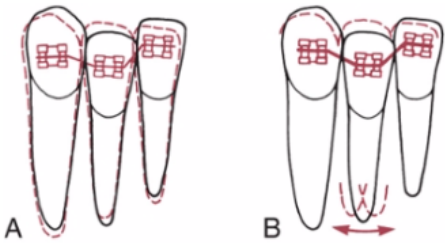
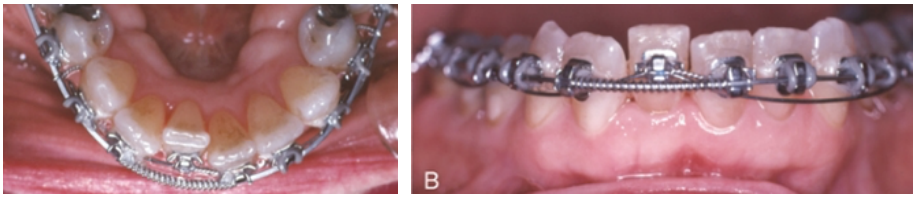
  → Start tx boys: About at **11 y**.

  → Start tx girls: About at **10.5 y**. 6 m before boys.
- Twin Block: Better compliance than with an activator because patients can speak.
- HG: 8 h necessary for retention. More (minimum 12 h) necessary for active tx.

Proffit Chapter 15:

Comprehensive Treatment in Adolescents: Alignment and Vertical Problems

- Comprehensive tx: = Effort to make the patient's occlusion as ideal as possible, repositioning all or nearly all the teeth in the process.	
Class I crowding / protrusion	
Alignment	- Components of the alignment: o Bring malpositioned teeth into the arch. o Specify and correct: ▪ Anterior-posterior position of the incisors ▪ Posterior width of the dental arches ▪ Form of the dental arches: Preserve the patient's original arch form for a more stable result. o Define if and how and curve of Spee will be leveled. - The final tooth position dictates the mechanotherapy necessary during alignment and leveling. - Alignment requires opening space for the teeth crowded out of the arch: o Compressed coil spring. o Crimped stops on the wire just in front of the molar tube. → Archwire is protruded. (slightly advanced from the crowded incisors). → Incisor proclination is about the same amount for both methods.
Properties of alignment arches	- Ideal wire: Flat load-deflection curve delivering about 50 gm force (optimal force for tipping). - <u>A-NiTi:</u> o Superelastic wire almost totally passive in the cold form, but delivers the desired force at mouth temperature. (E-modul Martensit ~= 40 MPa, Austenit ~= 80 MPa) o Light force over a large range. o Almost no alternatives. o Wire size is a concern primarily with respect to clearance in the bracket slot. o Chilling a segment of the wire (= transformation to Martensit phase) to make it temporarily passive can be a sign. advantage under some circumstances. - <u>Triple strand 17.5 mil multistranded ss wire (3x8 mil)</u> o Alignment time equivalent to A-NiTi if recontoured and retied with elastomeric ligatures monthly. o The flexible archwire allow teeth to move relative to each other during mastication, which releases binding and allows sliding of the bracket along the archwire. o Pro: Cheaper o Contra: ▪ Chairside time ↑ ▪ Force levels more variable ▪ Patient's discomfort ↑ → No longer recommended. - Wire with similar performance to multistranded ss wire: o M-NiTi. o Variety of more elaborate multistranded wires (coaxial wires). o Loops in small diameter SS-wires.
Principles in the choice of alignment arches	- Tooth buds can develop in the wrong place, but the root apices are likely to be close to their correct position. Exception: If all tissues are displaced in an area like for CLP or severe lip pressure in cl.II:2. → Combination of labiolingual and mesiodistal tipping needed for alignment, but no root movement. - Initially light continuous forces of approx. 50 gm to produce efficient tipping are recommended. Avoid heavy forces.

	- Archwires should move freely within the brackets. o Minimum **2 mil (optimum 4 mil) clearance** between the archwire and the bracket needed for mesiodistal sliding. More clearance has no additional benefit. o Archwire hold loosely in the brackets. - Normally avoid rectangular archwires esp. with a tight fit within the bracket slot to avoid apex movement. o Superelastic NiTi wires cannot torque roots, but produce mesial-distal movement of root apices which can slow down the tipping movement needed for alignment → back and forth movement of the root apex occurs before the tooth ends up in essentially the same position like with round wires. o Possibility for root resorptions. o Prefer round wires.  - The springier the wire, the more symmetrical the crowding should be. → Risk otherwise that the archform is lost when asymmetric irregular teeth are brought into alignment. (all other teeth experience a displacement force) - Prevent archwire travel: o Crimp a stop between any 2 brackets which are close together. o Cinch the end of the wire.
Asymmetric crowding	- Rigid archwire at the sides where the teeth are already aligned + a springy auxiliary superelastic wire if only one tooth is crowded out or an impacted tooth is brought into line. - If a superelastic wire is tied into an asymmetric malaligned arch, teeth distant to the site of malalignment will be moved. - Place a stiff main arch in all but the misaligned teeth + an auxiliary spring. Add a segment of superelastic NiTi in the brackets on top of the main archwire / tie it below the brackets of the anchor teeth and tie it to the brackets of the displaced tooth. 
Arch expansion for alignment	- Arch length must be increased for alignment in non-ex cases if crowding exists. - Limits for arch length increasement: o Esthetics. o Post-tx stability. - <u>Methods to increase arch length:</u> o **Crimp a stop** on the wire at the molar tube to hold the wire in front of the incisors. If a broad arch is used, transverse expansion over the premolars happens. Cave: Potential to carry the incisors facially. → Indicated only if incisor protrusion is desired. o Bypass the brackets on teeth which are lingually crowded and place **coil springs** over the A-NiTi. The archwire must be free to slide forward through the molar tube and slightly be too long initially so that it will not come out of the tubes. → Cave: Also, some proclination of the incisors / distortion of the archform if the force is too heavy. o **Transverse expansion** in the molar and premolar region. Cave:

	- Risk of fenestrations. - Expansion in the canine region cannot be avoided. - Heavy force which opens the midpalatal suture is not indicated to gain space for a crowding without a transversal deficit.
Alignment in premolar extractions situations	- Efficient alignment without incisor protrusion can be obtained with the combination of a small superelastic wire in the bracket slots and NiTi springs to retract the canines. - <u>Severe crowding:</u> Possibility to simultaneously tip the canines distally and align the incisors: A-NiTi archwire with exaggerated reverse curve of Spee (limit forward tipping of the molars) + a A-NiTi coil spring from the 1st molars to tip the canines distally. - <u>Extremely severe crowding:</u> Retract canines independently before placing attachments on the incisors. → Avoid a round trip.

Crossbite correction (that are largely dental)

- Skeletal CBs should be addressed prior to alignment.
- Dental CBs:
  - Posterior CB / mild anterior CB (1-2 teeth): Correct in the first stage of tx.
  - Severe anterior CB (all teeth): Correct in the 2nd stage of tx or even surgical.
  - Correction usually provides more space for the alignment.

Individual teeth displaced into an anterior CB	- = Expression of a severe crowding in most cases: → Opening the space, brings the tooth back. - Occlusal interference can make tx difficult: o Use temporary biteplates to create vertical space for tooth movement. Cave: ▪ Elongation of posterior teeth ▪ Mn downward & backward rotation. o During adolescence with rapid growth, trapped incisors in CB can correct without opening the bite. o The older the patient, the more biteplates are needed. - CB of > 2 teeth = Probably cl.III patient. → Dental correction is indicated only if camouflage tx is attempted.
Transverse maxillary expansion by opening the midpalatal suture	- Can provide enough space to make extractions unnecessary. (Don't use RPE to create space in individuals with normal mx width) - <u>Late mixed / early permanent dentition:</u> • SPE is more physiologic and equally effective as RPE. • Up until age 15 y, it is almost always possible to open the suture. • <u>Bonded expander:</u> o Easier to place. o Indicated for patients with excessive anterior face height. → Occlusal force against the acrylic reduces the extrusion and the mn downward-backward rotation which accompanies mx expansion. • <u>Banded expander:</u> Almost always some mn rotation, created by occlusal interferences as the teeth move. - <u>Older patients:</u> • RPE (SPE is likely to produce only dental expansion). • SARPE if the suture does not open.
Correction of dental posterior crossbites	Tx possibilities: - <u>Heavy labial expansion arch:</u> • Cave: Outward tipping of the crowns. • Patients with HG: Expand the inner bow. → Almost always needed for correction of a cl.II molar relationship. - <u>Expansion lingual arch:</u> • Must provide adequate springiness and range of action. • Flexibility ↑ = o Better for tooth movement o Anchorage stability ↓ - <u>Cross-elastics:</u> • Effective, but strong extrusiv component. o Adolescents: ▪ Tolerated. ▪ Some extrusion can be compensated by growth of the ramus. o Adults: Careful application. • May use a lingual arch in the mn to avoid lingual tipping of the molars. - Removable appliances should be reserved for the mixed dentition. - Biteplates to separate teeth tightly locked into a posterior CB can make correction easier and faster. - Cave: Downward-backward rotation of the mandible often results with any tx approach for posterior CB.

Impacted or unerupted teeth

- Procedure:
  1. Surgical exposure.
  2. Bonded attachment on the tooth.
  3. Orthodontic mechanics to bring the tooth into the arch.

- Same technique for incisors / canines & premolars. Different approach for lower 2nd molars.

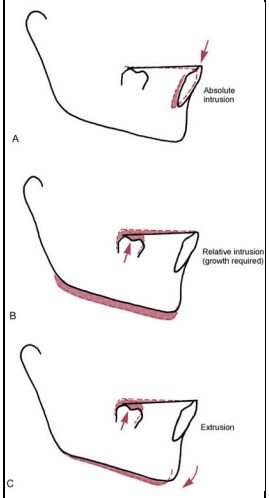
- Predictors for successful eruption of ectopic canines:
  - Prepubertal skelettal maturation.
  - Open root apex.
  - Vector of displacement not severe.

Surgical exposure	- The tooth must erupt through the attached gingiva, not through the alveolar mucosa. → Otherwise tissues will tip away from the crown, leaving an unsightly and periodontal compromised gingival margin. - Prior CBCT is recommended. Information gained can affect the tx plan. (how the impacted tooth is moved away from the roots and aligned) - <u>Exposure labially positioned mx canines or mn canines:</u> ○ **Laser**: Indicated if the tooth is not covered with attached tissue. ○ **Flap**: ▪ Indicated for more severe displaced teeth. ▪ Attached gingiva should be transferred and sutured to the region where the crown is exposed. ○ **Tunnel method**: Alternative to a flap for very high positioned canines. - <u>Palatally positioned mx canines:</u> Gingiva problems are not an issue and an open exposure can be used. - <u>Teeth with incomplete root formation:</u> Delay orthodontic traction: → Teeth obligingly erupt in the correct position after obstacles have been removed. - <u>Teeth with completed root formation:</u> Favorable spontaneous movement rarely occurs.
Method of attachment	- Place a button or a hook to the exposed crown area and place a fine gold chain to the attachment. - If bonding is not possible, place a pin in a hole prepared into the crown. Cave: Very invasive. - Don't place a wire ligature around the crown: ○ Loss of periodontal attachment. ○ Chance of ankylosis ↑.
Mechanical approach for aligning unerupted teeth	- The cells in the follicle that allow bone resorption around the enamel are no longer present after the surgical intervention. → Any bone left in the direction of the impacted crown movement will be difficult or impossible to become resorbed. → Adequate bone needs to be removed, so that no enamel-to-bone contacts is created while the tooth is brought into the mouth. - Move the tooth away from other permanent teeth and then towards the line of the arch as soon as possible after the surgery. Maximum 2-3 w delay after surgery. - A fixed appliance should be in place before the unerupted tooth is exposed. Presurgical tx should create enough space if it does not exist and allow to place a heavy stabilizing archwire. - Bring the exposed tooth down: • Auxiliary NiTi wire. • Alignment spring soldered to a heavy base archwire or bent into a light archwire. • Cantilever spring form the auxiliary tube of the first molar. • Magnetic force for mx teeth. (one magnet on the unerupted tooth, one on a palate covering removable appliance)

	- Palatal impacted canines: o Open exposure often leads to a downward drift. → Immediate active tx can be deferred for most patients. - Cave: Ankylosis is likely to occur during alignment of impacted teeth. → Tooth can sometimes be freed by anesthetizing the area and slightly luxating the tooth in order to break the area of ankylosis. Orthodontic force must be applied immediately after the luxation.
Unerupted / impacted lower 2nd molars	- Mesial tipped molars in the mixed dentition often correct spontaneously when 6-6 drift mesial. - Usually develops during orthodontic tx: Moving the 1st molar posteriorly during the mixed dentition, increases the chance for impaction of a 2nd molar. → Delay or avoid banding lower 1st molars. - <u>Therapy</u>: • Tip the tooth posterior and upright it by placing a separator. If the mesial marginal ridge can be unlocked, the tooth will erupt on its own. • <u>More severe cases:</u> Bond an attachment on the 2nd molar and place an auxiliary spring from the 1st to the 2nd molar. (e.g. 16x22 M-NiTi overlay arch if a fixed appliance is in place) • <u>Adolescents:</u> Surgical upright the impacted 2nd molar in the space of a simultaneously extracted 3th molar. Vitality is retained as the tooth is only rotated around the apex. The outcome is best, when some vertical jaw growth remains so that the 2nd molar is not elongated in relation to the 1st molar.

Diastema closure	
Frenulum	- Frenectomy: o Simple incision to allow removal of interdental fibrous tissues. Remove the fibrous connection to the bone and suture the frenulum at a higher level. o Don't excise a large portion of the frenulum itself. - Align the teeth before frenectomy: o <u>Relatively small diastema:</u> Teeth can normally be brought together before surgery. o <u>Large space & thick frenulum:</u> Space can maybe not completely be closed before surgery. A reduction should be achieved before surgery and closure resumed immediately after the frenectomy. o Better slide the teeth along an archwire instead of a closing loop. → Vertical height of the loop will touch and irritate the frenulum. - Avoid frenectomy at an early age in the hope that the diastema will close spontaneously. → Scar tissue is formed between the teeth and a long delay until orthodontic tx starts makes the diastema closure maybe more difficult. - Bonded fixed retainer for retention. (no elastic gingival fiber network which cross the midline)

Leveling



- Possibilities to level out an excessive curve of Spee:

- <u>Absolute intrusion:</u>
  Indicated normally for patients who are too old for relative intrusion.

- <u>Relative intrusion:</u>
  = Achieved by preventing eruption of the incisors while growth provides vertical space into which the posterior teeth erupt.
  (differential elongation of premolars)
  The ramus grows while tooth movement occurs.
  Quite acceptable for adolescents.

- <u>Extrusion of posterior teeth:</u>
  → Causes the mandible to rotate down- & backwards in the absence of growth.

Leveling by extrusion (relative intrusion)

- = Place an exaggerated curve of Spee in the mx archwire and a reverse curve of Spee in the mandibular archwire.

- <u>18-Slot, narrow brackets:</u>
  - 16 mil steel archwire after initial alignment.
  - If no growth is remaining:
    Auxiliary leveling arch 17x25 mil TMA / steel arch inserted into the auxiliary tube on the molar and tied anteriorly beneath the 16 mil base arch.
    → Curve in the base arch is augmented.

- <u>22-Slot, wider brackets:</u>
  1. Initial alignment with A-NiTi.
  2. 16 mil steel wire with a reverse or accentuated curve of Spee or 16 mil A-NiTi with a reverse curve of Spee.
     → If little growth is remaining:
     18 mil ss wire with a reverse or accentuated curve of Spee.
  3. 18 mil ss round wire to complete the leveling.

- Don't place a rectangular archwire with an exaggerated curve of Spee in the mn arch with either slot size → Curve creates torque to move the incisor roots lingually. Acceptable in the maxilla if some lingual root torque of the upper incisors is needed
- The arches should be leveled before a rectangular wire is placed.

Leveling by intrusion

- Avoid pitting intrusion of one tooth against extrusion of its neighbor.
  → Extrusion will dominate.
- *Preston, 2008*:
  Stability of leveling with continuous archwires or sectional intrusion archwires is equally stable.
- Intrusion requires segmented base arches and a light intrusive force:
  About **50 gm for 321-123**.
- Intrusion is essentially impossible with a continuous arch wire, but an auxiliary leveling archwire can be useful in augmenting the leveling force from a wire tied into the brackets.

- Extrusion can be done with a segmented or continuous archwire by using about 50 gm per tooth in the segment to be extruded.

1. Bypass arches:

- = Continuous archwire that bypasses the premolars and frequently the canines.
  Examples:
  - Originally used in the Begg technique
    (premolars bypassed, only loosely tied around the canines)
  - Rickett's utility arch (rectangular wire)

- Idea:
  Uprighting and distal tipping of the molars is pitted against intrusion of the front teeth

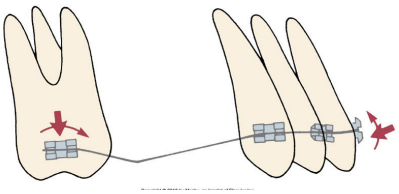
- Indicattion: Patients with a lot of vertical growth. (to compensate molar extrusion)

- Methods:
  - 2x4 appliance or
  - Premolars & canines are bypassed (not tied in the main archwire)

→ The long span of a 2 × 4 appliance makes it possible to create the light force necessary for incisor intrusion and also makes it possible to create unwanted side effects. This appliance is best described as deceptively simple. When incisor intrusion is desired before other permanent teeth can be incorporated into the appliance, a transpalatal lingual arch for additional anchorage is a good idea.

- Clinical use:
  - Use light arches e.g. **16x22 B-TMA**, maximum 16 mil ss.
  - Overactivation of the vertical bends can cause loss of the molar control.

- Contras:
  - Limited amount of intrusion can be achieved.
  - Only the first molar is available for anchorage.
    (expect in some applications of the utility arch)
    → Sign. extrusion of the posterior teeth can occur → toleration only in growing patients.
  - The intrusive force is applied anterior to the incisors:
    - Trend to forward tipping during intrusion.
      → This can be counteracted by cinching the wire back, but this moves the molars mesially.
  - Utility arch:
    - = rectangular shape → can be activated (like a closing loop) to keep the incisors from moving forward and twisted to control the tipping. Force system of the 3t^{h} order can increase or compensate the vertical equability forces. *(Davidovitch + Rebellato, 1996)*
    - → Cave: Strain on the posterior anchorage, intrusive force cannot be controlled.

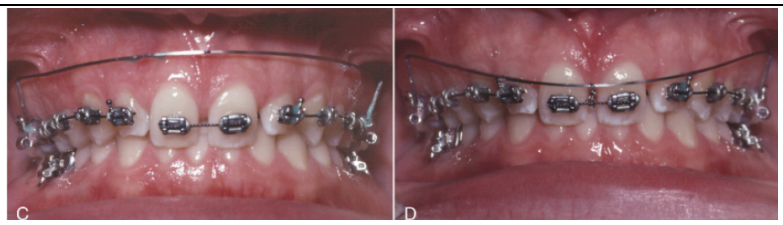


Diagrammatic representation of the forces for a leveling arch that bypasses the premolars, with an anchor bend mesial to the molars. A force system is created that elongates the molars and intrudes the incisors. The wire tends to slide posteriorly through the molar tubes, tipping the incisors distally at the expense of bodily mesial movement of the molars. An archwire of this design was used in the first stage of Begg treatment but also can be used in edgewise systems. A long span from the molars to the incisors is essential.

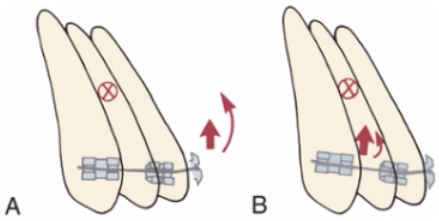
2. Segmented arches and an auxiliary depression arch

- Developed by Burston.
- No connection of the anterior and posterior arch segments.

- Method:
  - **Full dimension rectangular archwires** placed into the brackets slots of the teeth in the buccal segments for stabilization.
  - Heavy **lingual arch** (36 mil round / 32x32 rec. steel wire) to connect right and left posterior segments.
  - Resilient anterior segmental wire used to align the incisors while the posterior segments are being stabilized.
  - For intrusion:
    - Auxiliary arch in the auxiliary tube on the 1st molar applying intrusive force against the anterior segment.
    - Chose a rectangular wire that will not twist:
      17x25 steel / 19x25TMA.
    - The wire lies gingival to the incisor teeth when it is passive and applies a light force → tied underneath or in front of the incisors.
  - Applied force: **~10 gm per tooth / 150 gm with continuos archwire**
  - The light resilient anterior segment can be used to align malpositioned incisors together with the auxiliary intrusion archwire. But usually better wait until alignment has been achieved and a heavier anterior segmental wire (rectangular ss or TMA) can be installed.



- <u>Forward movement of the incisors must be prevented:</u>
  - Tip back the auxiliary arch against the posterior segments to create a space closing force.
    → Cave: Strain on the posterior anchorage in mesial direction.
  - Vary the point of force application against the incisor segment in relation to the center of resistance of the whole segment.
    - Tying the depressing arch distal to the midline between the central and lateral incisors or distal to the laterals.
    - The point of force appliance is more posterior and the force closer applied through the center of resistance.



A) When the incisor segment is viewed from a lateral perspective, the center of resistance (X) is lingual to the point at which an archwire attaches to the teeth. For this reason, the incisors tend to tip forward when an intrusive force is placed at the central incisor brackets. (B) Tying an intrusion arch distal to the midline (for instance, between the lateral incisor and canine, as shown here) moves the line of force more posteriorly and therefore closer to the center of resistance. This diminishes or eliminates the moment that causes facial tipping of the teeth as they intrude.

- Cave:
  Extrusion & distal tipping of the posterior segment as reaction to the incisor intrusion.
- Intrusion / extrusion rate of 4:1 can be achieved.

- Asymmetric intrusion possible:
  - <u>Asymmetric activation of the intrusion arch</u>:
    Tie the auxiliary arch at the point where intrusion is desired + adjust the teeth in the stabilizing segment.
  - <u>Cantilever auxiliary</u> wire from one molar.

3. Aligners	- Attachments on the posterior teeth avoid that the aligners slide down posteriorly when an upward force is placed on the anterior teeth
4. Skeletal anchors	- Eliminate the problem of unwanted movement of the anchorage teeth. - Necessary for intrusion of posterior teeth to correct a tipped palatal plane. - - Miniscrews / miniplates: • The amount of force which can be placed against a bone screw is well within the force magnitude needed for tooth movements. • Make tx more effective.
Discussion	- Levelling mesial in rotated 1st molars: Archwires lies buccal to the 2nd molars. → Buccal tilting + bite opening effect when 2nd molars are leveled.