

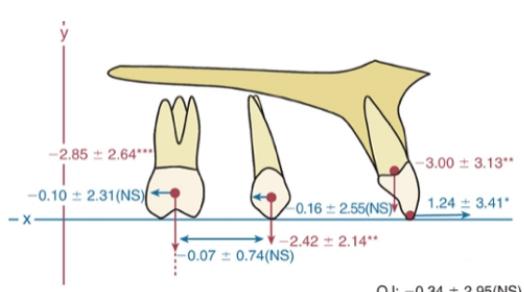
Proffit Chapter 16:

Comprehensive Treatment in Adolescence:

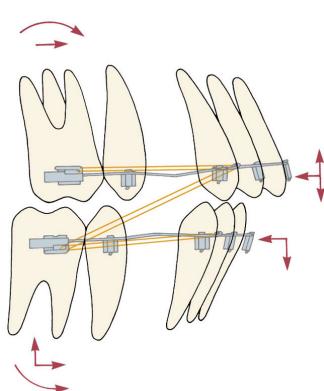
Space closure and Class II / Class III Correction.

Class II correction in adolescents	
<ul style="list-style-type: none"> - 2 possibilities without surgery: <ol style="list-style-type: none"> 1. Differential growth of the jaws guided by EO force or a functional appliance. 2. Differential anteroposterior movement of the upper and lower teeth with or without differential closure of extraction spaces. - A combination of both approaches is possible. Even successful growth modifications typically provides only a partial correction of a full class II/III malocclusion. → Some tooth movement is almost always needed to correct the molar relationship. 	
1. Differential growth in adolescent class II tx	<ul style="list-style-type: none"> - Forward growth during adolescence: Mandible > maxilla. - Gender differences: Boys are with 13 y at the same stage of maturation as girls with 11 y of age. <ul style="list-style-type: none"> • Girls: Peak of growth spurt often before the full dentition is present. • Boys: Clinical useful rest of growth in the early mixed dentition. - A functional appliance can be used in immature patients with a permanent dentition before a fixed appliance is inserted for the correction of the occlusal details. Cave: The functional appliance has to be modified or discontinued when the fixed appliance tx starts. - Intermaxillary elastics or flexible spring devices: Growth modification seems unlikely in adolescents. - HG: <ul style="list-style-type: none"> ○ Compatible with fixed appliance tx. ○ Space development is unusual between 6/5+5/6. 54+45 follow the molars. → Space opens distal the canines. - Herbst appliance: Rarely space opening within the mx arch in the early permanent dentition.
2. Class II correction by distal movement of upper molars	<ul style="list-style-type: none"> - Limits: Sign. distal positioning of the upper posterior teeth in relation to the mx occurs primary in patients with vertical growth and elongation of the maxillary teeth: The molars and premolars are tipped distally during eruption. Otherwise hardly > 2-3 mm distal movement of 6+6 (4-6 mm with TADs) can be achieved except 7+7 are extracted - Correction of mp rotated 6+6 provides a small space mesial. Note: Wire lies buccal to the 2nd molars → buccal tipping → extrusion due to tipping. - <u>A-NiTi coil spring</u> compressed against the molars (from an anterior anchorage unit) can produce an effect and a nearly constant force system for distal movement. - <u>Magnets in repulsion</u> can be used. → Cave: Force amount changes as tooth movement occurs. - HG: <ul style="list-style-type: none"> ○ High force with relatively limited duration. ○ > 2 mm movement of 6+6 is only achieved when they are simultaneously elongated. (allowed only in good vertical growers) ○ Highpull HG is not very efficient for distalizing molars. - <u>Cl.II elastics</u>: <ul style="list-style-type: none"> ○ Can be applied to a sliding jig to concentrate the force to the molars (mainstain of the original Tweed technique).

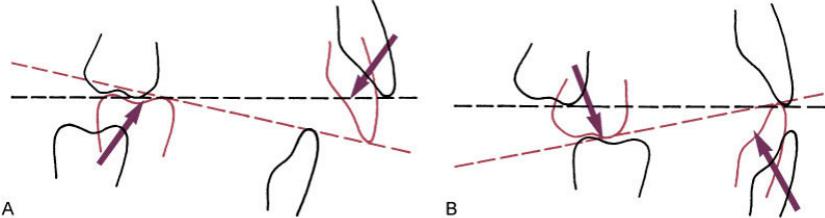


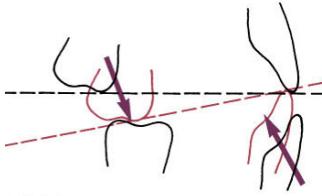
	<ul style="list-style-type: none"> ○ Risk of mesial movement mn teeth > distal movement mx teeth. ○ Elongation of mx & mn teeth. <p>- <u>Palatal anchorage:</u></p> <ul style="list-style-type: none"> ○ Removable appliances (Nance, Pendulum) contacting the palate are not effective in molar distalization → fit is may not good enough. ○ Mainly prevents tipping and mesial in rotation of the premolars. ○ Contact on the palate can cause tissue irritations. <ul style="list-style-type: none"> ○ <u>Pendulum</u> is successful to push the molars back to gain space, but the space is lost during later space closure. (<i>Byloff, 1997</i>) <ul style="list-style-type: none"> ■ Beta-titanium wire 200-250 gm force. ■ Molar movement on average 1 mm/m. ■ Side-effects: Distal tipping of the crown and elongation of the molars. Premolars / incisors tip anteriorly. ■ Leave distalization appliance 2-3 m in place after the distal movement of 6+6: → Premolars are moved back by the stretch of the gingival fibers. ■ Tip forward bend in the wire during distalization: → Tipping of the molar ↓, distal movement of the roots ↑ BUT displacement of the incisors ↑, tx time↑.  <p>Mean changes in tooth position relative to the maxilla in a sample of 35 Class II patients treated with a first phase of pendulum appliance molar distalization followed by comprehensive fixed appliance treatment, with a mean treatment duration of 3.1 ± 0.6 years. Note the small average net distalization of the molars relative to the maxilla. In the final analysis, successful correction of the Class II malocclusion was due more to jaw growth, transverse expansion of the dental arches, and forward movement of the lower incisors than to distalization of upper molars.</p> <p>- <u>Miniplate anchorage:</u></p> <ul style="list-style-type: none"> ○ Works well as direct or indirect anchorage to move the whole arch or a single unit of posterior teeth back. ○ All the maxillary teeth can be moved back simultaneously. <p>- <u>Alveolar bone screws:</u></p> <ul style="list-style-type: none"> ○ If alveolar bone screws are placed between the roots: Mesio-distal movement of the teeth is blocked: → Screws must be repositioned during space closure. ○ Risk of screw failure. <p>- <u>Palatal bone screw anchorage:</u></p> <ul style="list-style-type: none"> ○ Indirect anchorage from this area is the most efficient way to move molars distal and hold them there while the other teeth are retracted into this area. ○ Expansion will be needed if molars are distalized. ○ Intrusion would be expected, because the anchor is in the depth of the palate. ○ Extraction of 7+7 or 8+8 is maybe necessary to prevent impaction or difficult extractions. → 8+8 normally erupt well in the extraction space of 7+7 and bring bone with them. ○ Moffitt, 1998: 75-80% chance that 8+8 satisfactorily replace 7+7. ○ Very effective, so that overretraction of the upper incisors is possible.
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3. Differential anteroposterior tooth movement using extraction spaces	- Extraction space needed for alignment ↑ = Extraction space for differential movement in camouflage ↓
- A: Distalization of 6+6 after ex 7+7	<ul style="list-style-type: none"> - 4-5 mm short-term distal movement of 6+6 expected with ex 7+7, however a big part is likely to be lost in long-term. - Greater distalization of 6,5+5,6 possible with skeletal anchorage when 7+7 are extracted. - <i>Moffitt, 1998:</i> 75-80% chance that 8+8 satisfactorily replace 7+7.
- B: Class II camouflage by extraction of 4+4	<ul style="list-style-type: none"> - Camouflage = Correcting the malocclusion if the facial appearance is acceptable without treating the skeletal jaw discrepancy. - Goal: Maintain class II molar relationship and lose the extraction space by retracting protruding incisors. - Anchorage: <ul style="list-style-type: none"> • EO force on 6+6 + stabilizing lingual arch → Lingual arch: <ul style="list-style-type: none"> ○ Prevent mesial-lingual rotation of 6+6 around the palatal root. ○ Prevent mesial tipping of 6+6. ○ A lingual arch with a button against the palatal tissue is not more effective than a straight transpalatal lingual arch to stabilize 1st molars in a premolar extraction case. • Skeletal anchorage necessary to retract the mx anterior segment. • Cl.II elastics are contraindicated unless the lower teeth should be moved forward. - No evidence that TMJ problems are provoked (was a claim in the past). - Consider facial appearance when moving maxillary teeth back. - If the malocclusion is due to a mn deficit, retracting the maxillary incisors also creates a maxillary deformity. Don't do! - J-hook headgear: (HG attached to the archwire) <ul style="list-style-type: none"> ○ Pro: No strain on the posterior teeth. ○ Contra: Interruptive force, sign. binding and friction. → Often leads to asymmetric space closure.
- C: Extraction of maxillary and mandibular premolars	<ul style="list-style-type: none"> - <u>Ex 4+4:</u> <ul style="list-style-type: none"> • Mn posterior segments must be moved anteriorly nearly the whole width of the extraction space. Mx anterior teeth must be retracted without forward movement of the mx buccal segment. → Use of class II elastics indicated. • Edgewise appliance: <ul style="list-style-type: none"> ○ Crown tipping for space closure is difficult with the width of the bracket. ○ A segmental arch approach is preferred. • Begg approach: Space closure by tipping the crowns. <ul style="list-style-type: none"> - Add light intraarch elastics to help space closing at the beginning while class II elastics are continued. - Use light force = optimum force levels for tipping, while force for bodily movement should remain suboptimal. - Anchor bends to counteract tipping: <ul style="list-style-type: none"> ○ → Maxilla: Anterior teeth tend to tip backward. ○ → Mandible: Control of mesial tipping of the molars.



Forces encountered in the second stage of Begg treatment, in which base archwires (grey) with anchor bends are combined with intra-arch and Class II elastics (orange). The anchor bends produce bodily forward movement of the molars, but no couples are present on the incisors, so these teeth tip lingually. The anchor bends also depress the incisors and elongate the molars, which is counteracted by the Class II elastics for the upper arch but accentuated by the elastics for the lower.

	<ul style="list-style-type: none"> - Ex 4+4, 5-5 <ul style="list-style-type: none"> • 6-6 will be moved more mesially than 6+6, because of the different anchorage value of the units. • Mesial movement of a 6-6 is difficult if 5-5 are congenitally missing. Extraction V-V: First only the distal root + Ca(OH)² pulpotomy and temporary restoration, because bone resorption reduces the alveolar ridge dimension before space closure can be completed.
4. Nonextracti on correction with interarch elastics	<ul style="list-style-type: none"> - Cases without extraction-spaces: Molar correction largely by mesial movement of the mn arch and only a small amount of distal positioning of the mx arch. Cave: Class II patients have the lower teeth almost always normally positioned or proclined → too much protrusion of the lower incisors → relapse likely. (Soft tissues allow max. 2 mm incisor protrusion, afterwards there is a sharp increase in force) - 250 gm per side needed to displace one arch relatively to the other with a rectangular wire in the lower arch. Less force if a lighter round wire in the lower arch is placed. - Incorporate 7-7 in the appliance and hook elastics to 7-7: → More horizontal direction of the pull. - Cave: Always a vertical force! Occlusal plan rotates posterior up and anterior down (molar extrusion > vertical growth) → Cl.II elastics contraindicated in non-growing patients who cannot tolerate downward-backward rotation of the mandible <div style="text-align: center;">  <p><i>Rotation of the occlusal plane with Class II (A) and Class III (B) elastics.</i></p> </div> <ul style="list-style-type: none"> - A good short-term effect in the occlusal relationship can maybe be achieved with cl.II elastics, but they are less satisfactory considering skeletal relationship and dental esthetics. → Not indicated for a major cl.II correction, but acceptable to install a good posterior interdigitation at the completion of tx.

Class III camouflage	
<ul style="list-style-type: none"> - = Procline maxillary incisors and retract mandibular incisors into an extraction space. → Cave: Makes the chin more prominent. 	
<ul style="list-style-type: none"> - Indications: <ul style="list-style-type: none"> • If the reversed OJ is largely due to protrusive mandibular incisors and retrusive maxillary incisors. • More maxillary deficiency than mandibular prognathism. 	
Cl.III elastics	<ul style="list-style-type: none"> - Extrusive component → Downward-backward rotation of the mn helps cl.III correction for patients with a short anterior face height. 
Extraction 4-4, 5+5	<ul style="list-style-type: none"> - Retraction of the lower incisors makes the chin more prominent. → Acceptable in Asian people who often have dental protrusion, but normally not for Caucasians.
Extraction of mn premolars	<ul style="list-style-type: none"> - Can be successful, if the lower incisor retraction is carefully controlled.
Extraction of one lower incisor	<ul style="list-style-type: none"> - Good approach for Caucasian patients. - Prevents major retraction of the lower teeth, while the mx incisors are moved facially with some tipping. - Upright mandibular incisors with proclined mx incisors often end in good dental occlusion rather than expected tooth-size problems. - A primary setup is mandatory.
Lower arch distalization	<ul style="list-style-type: none"> - Skeletal anchorage allows to move the whole lower arch distal. - Indicated if the lower incisors are severely protruded. - Extraction of 8-8 is maybe needed in case of extensive distalization. - If 7-7 are extracted to improve distalization, 8-8 normally do not erupt as satisfactory replacement like in the mx → not recommended to perform routinely.
Asian patients	<ul style="list-style-type: none"> - Often have dental protrusion → retraction of lower incisor and downward and backward rotation of the mn is better tolerated than for Caucasians.

Space closure in incisor protrusion problems: Sliding versus loop mechanics in space closure

- A force to move the teeth + a root-parallel moment to move achieve bodily movement is necessary for space closure.

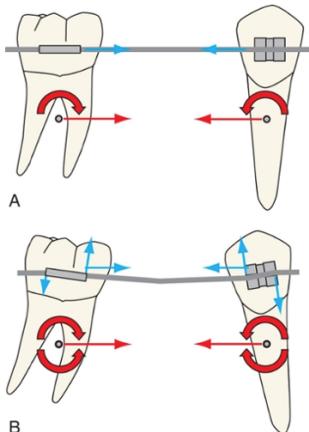
TABLE 16.1 Sliding Versus Loop Mechanics

Method	Sliding teeth on an archwire	Closing loop between segments
Generation of force	Alastic or NiTi spring to single tooth or group of teeth	Activate the loop
Net force desired	100gm per tooth	150gm per segment
Resistance to sliding	Approximately 100gm per tooth	None
Generation of moment	Automatic (bracket width)	Gable bend, approximately 45 degrees

NiT, Nickel-titanium.

1. Sliding mechanics

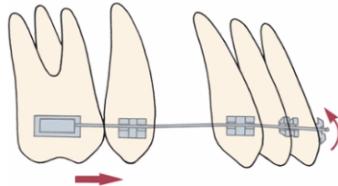
- The wire must be undersized relative to the bracket and strong enough not to bend sign. when force is applied across the section that spans across the extraction site.
- Contact between wire and bracket closer → friction ↑
- **0.03 inch = 0.5 mm** difference between bracket slot and wire is enough to largely avoid friction.
 - o Most brackets are slightly larger than the nominal size.
 - o Most wires are slightly smaller than the nominal size.
- An uprighting moment is generated in the bracket when the tooth begins to tip and contacts the corners of the bracket.
 - Uprighting if the wire does not bend.
 - Tipping if the wire bends.



A, When a retraction force is placed on the brackets (blue arrows), the center of resistance feels both a translational force and the moment of a force that initially causes tipping (red arrows).

B, As the teeth tip, the wire engages at opposite edges of the bracket, creating a couple that resists tipping. After a certain level of tipping occurs, the moment of the couple and the moment of a force are in equilibrium and no further tipping occurs. This equilibrium point depends on the retraction force, wire stiffness, interbracket span, and bracket width.

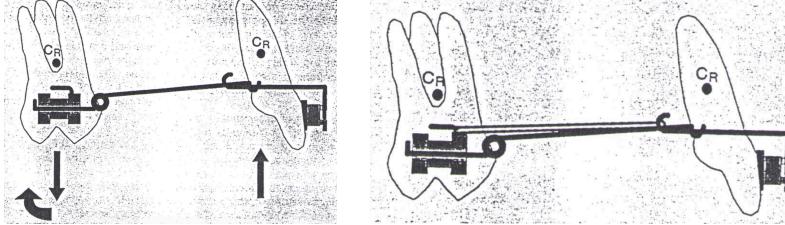
- **Bracket width ↑ → binding forces ↓**
Ideal bracket width = $\frac{1}{2}$ width of the teeth. (larger = alignment impeded)
- **Arm of the uprighting moment = $\frac{1}{2}$ bracket width**
- Mechanisms to generate force:
 - o NiTi coil springs: ideal
 - Pro: Force known and constant.
 - o Elastics chains:
 - Contra: Quick force decay.
 - Pro: Easier placement, oral hygiene easier?
- Sliding = fail safe mechanism.

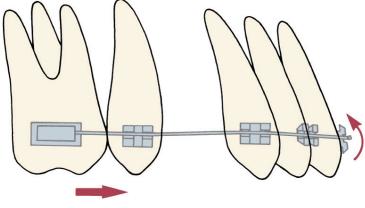
	<ul style="list-style-type: none"> - Torque of the incisors if often needed during retraction. Cave: Reciprocal mesial directed force on the molars (advantageous in cl.III patients). 
2. Closing loop mechanics	<ul style="list-style-type: none"> - Use rectangular wires to prevent the wire from rolling in the bracket slot. - Frictionless: → Potential to reduce anchorage problems and reduce time for space closure. - Factors influencing the spring characteristics: <ul style="list-style-type: none"> ○ Spring properties: = Amount of force delivered and how the force changes as the teeth move ○ Moments generated to control the root position. ○ The location of the spring relative to adjacent brackets = The extent to which it serves as a symmetric or asymmetric bend in the archwire. - <u>Properties of closing loops determined by:</u> <ul style="list-style-type: none"> ○ Wire material: SS or TMA recommended, TMA exerts always about ½ force of ss. ○ Wire size: Largest changes in characteristics. ○ Distance between the points of attachment: Affected by the amount of wire incorporated into the loop and the distance between the brackets. ○ Center of the apical portion of the loop: Regardless of the position of the loop legs. <p>→ Closing loops with similar properties can be produced from different wire materials and different wire sizes. → Simpler loop designs are possible with wires of greater inherent springiness or smaller cross-sectional areas.</p> <p style="text-align: center;"><i>Booth, 1971</i> "The effects on force of changing various aspects of a closing loop in the archwire"</p> <ul style="list-style-type: none"> - <u>Root-parallelizing moments:</u> <ul style="list-style-type: none"> • The requirement to generate a moment limits the amount of wire that can be incorporated into a closing loop to make it springier. Loop too flexible → no moments generated. • Placing some of the wire in the closing loop in a horizontal rather than a vertical direction improves the ability to deliver the moments needed to prevent tipping.

	<p>→ Ideal: Closing loop 7-8 mm tall while incorporating 10-12 mm wire. (no impinging on soft tissue)</p> <ul style="list-style-type: none"> Opening the parallel legs of a loop generates moments in the desired direction, but they are too small (unless the loop is not unacceptable tall) → Additional root-paralleling moments must be created by gable bends. <p>- <u>Location of the loop:</u></p> <ul style="list-style-type: none"> Closing loops function as a V-bend: <ul style="list-style-type: none"> Loop placed in the center of a span (geometrie VI): → Equal forces and couples on the adjacent teeth. One third of the way between adjacent brackets (geometrie IV): → Tooth closer to the loop extrudes & feels a moment to bring the root toward the V-bend. V-bend closer to one bracket than $\frac{1}{3}$ (geometrie I/II/III): → The more distant tooth will not be intruded but receives a moment to move the root away from the V-bend. Preferred location = spot which will be the center of the embrasure when the space is closed. e.g. 5 mm distal to the center of the canine tooth in case of extraction 4+4. <p>- <u>Additional design principles:</u></p> <ul style="list-style-type: none"> Loops should be "fail safe": Tooth movement should stop after a prescribed range of movement (1 mm per month). Not more than 2 mm range. Keep the design as simple as possible: → More comfortable for patients, easier to fabricate clinically, less risk for breakage / distortion, but maybe less efficient. <p>→ Opus loop: Optimum and nearly constant moment-to-force ratio at variable activations. Produced from wires 16x22 / 18x25 SS or 17x25 TMA. Cave: Clinical complex, risk for distortion by the patient.</p> <ul style="list-style-type: none"> <u>Activation modus:</u> <ul style="list-style-type: none"> A loop is more active, when it is closed rather than opened during its activation (Sicherheitsnadel-Prinzip). Loops designed to be opened during activation: → Vertical legs in contact when it closes completely preventing further movement = fail safe effect. Loops activated by closing: Vertical legs overlap → Creation of a transverse step. The archwire does not develop the same rigidity when it is deactivated. (important esp. for smaller and flexible wires)
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Correction of bimaxillary protrusion

	<ul style="list-style-type: none"> - Usually 4±4 are extracted. - The clinical management depends of how much incisor retraction is needed.
Moderate anchorage situations:	<ul style="list-style-type: none"> - 2 step space closure: Divide the space closure into 2 steps: <ol style="list-style-type: none"> 1. Retract the canines (sliding along the archwire). 2. Retract the 4 incisors (closing loop). - Failsafe.
Lückenschluss B (reziprok)	<ul style="list-style-type: none"> - Takes longer to close the spaces than one step space closure. - <u>1st step:</u> <ul style="list-style-type: none"> • 19x25 ss wire = Largest on which sliding retraction of a canine should be attempted (minimum 0.03 mil clearance in the bracket slot needed). • Posterior stop usually in front of the first molar tube needed. • Canine retraction with: <ul style="list-style-type: none"> ◦ A coil spring: → A-NiTi coils springs preferred: Almost ideal light constant force. ◦ An elastomeric material. ◦ A spring soldered to the base archwire.  <ul style="list-style-type: none"> • Sliding space closure is fail safe: <ul style="list-style-type: none"> ◦ Moments necessary for root paralleling are generated automatically by the twin brackets: → No danger that teeth will tip excessively. ◦ Rigid attachment of the canine to the continuous ideal archwire removes the danger that this tooth will be moved far outside the intended path. → A long range of action for the retraction spring can be used, as long as the force is not excessive (ideal 150-200 gm). - <u>2nd stage:</u> <ul style="list-style-type: none"> • Mandible: Continue with sliding or a closing loop. • Maxilla: Closing loops are preferred when a greater incisor torque is needed. (most often the case) <ul style="list-style-type: none"> ◦ 60:40 (60% anterior retraction, 40% posterior protraction) closure of the extraction space can be expected, depending if 7+7 are included in the anchorage and the amount of required torque. → En masse closure would lead to 50:50 closure. ◦ Rectangular wire with the smallest side at least 18 mil: Preferred 19x25 Beta-Ti → More efficient, but more difficult for forming than 18x25 SS. → 19x25 SS = too stiff, no failsafe design possible. - <u>One stage space closure with segmented arch technique</u> <ul style="list-style-type: none"> • The anterior teeth are incorporated in a segment and the posterior right and left teeth in individual segments. • The posterior teeth on both sides can be stabilized by a lingual arch. • Retraction springs can be used to connect the stable bases and the activation is varied to produce the desired pattern of space closure. (positioned into the auxiliary tube on the first molar and a rectangular vertical tube on the canine or on the anterior wire segment). • Cave: Not fail safe: Arch form and vertical relationship are not maintained if a retraction spring is distorted or activated incorrectly.

	 <p style="text-align: center;">3-piece base arch</p>
Moderate anchorage situations: Space closure with the 18-slot edgewise	<ul style="list-style-type: none"> - 18-slot appliance fits better for a design with closing loops. (18 -slot is too narrow for good sliding: Tight clearance, low strength of 17x25 archwire). - The wire slides through the brackets / tubes only when it is being activated. After that, when the closing loop returns to its original configuration, the teeth move with the archwire, not along it → no resistance to sliding. - Ideal closing loop = delta-shaped loop in 16x22 ss activated by opening with 10 mm wire in the loop. Activate the upper horizontal portion of the loop so that the vertical legs are pressed lightly together when the loop is not activated. 1-1.5 mm activation. - Activation of the loop: <ul style="list-style-type: none"> o Bend the archwire gingivally behind the last molar. o Place an attachment (usually a soldered tie back) on the archwire so that the archwire can be tied with a ligature in the activated position. - Gable bends must be reactivated after 3-4 mm space closure. - If heavier wires are used, the loop design should incorporate additional wire for better force-deflection characteristics. - Adjust the gable bends to the springiness of the loop and the width of the brackets. - Wide brackets are not recommended when closing loops are used. - <u>Specific recommendations for closing loop archwires with 18-slot appliance & narrow brackets:</u> <ul style="list-style-type: none"> o 16x22 ss wire. o Delta or T-shaped loops. o 7 mm vertical height, additional wire incorporated into the horizontal part of the loop (to make it equivalent to 10 mm height). o Gable bend of 40-45° total (half on each side of the loop). o Loop placement 4-5 mm distal to the center of the canine tooth, at the center of the space between the canine and second premolar with the extraction site closed.
Maximum incisor retraction (maximum anchorage) Lückenschluss A	<ul style="list-style-type: none"> - 2 approaches to achieve maximum incisor retraction: <ul style="list-style-type: none"> • Reinforcement of the posterior anchorage. • Reduction of the strain on the posterior anchorage = Combination of <ul style="list-style-type: none"> o Eliminating resistance to sliding from the retraction system. (i.e. closing loops) o Tipping the incisors and later uprighting them (Begg technique) o Retracting the canines separately (Tweed technique)
1. Reinforcement with stabilizing lingual arches 2:1 ap closure	<ul style="list-style-type: none"> - Mandible: <ul style="list-style-type: none"> o Lingual arch should lie behind and below the lower incisors, so that it does not interfere with retraction. - Maxilla: <ul style="list-style-type: none"> o No loops in order avoid reducing the rigidity of the wire. - Remove lingual arches after the spaces are closed. (interference with the settling is possible) - If proceeded with en masse space closure: 2:1 anterior-posterior ratio for space closure.
2. Reinforcement with HG and interarch elastics 3:1/4:1 ap closure	<ul style="list-style-type: none"> - Mx: HG - Mn: Cl.III elastics + highpull HG → Force from the upper arch is transferred to the lower arch. Easier than to place eo force directly on mn molars. - 3:1 or 4:1 space closure ratio depending on the patient's cooperation. - Cave: Extrusive component. - HG reinforces posterior anchorage, but is inefficient in comparison with skeletal anchorage.
3. 2-step frictionless retraction 3:1 ap closure	<ul style="list-style-type: none"> - Segmented retraction of the canines. - 3:1 retraction ratio if used with a stabilizing archwire (tpa / lingual arch). - Retraction of the canines by segmented closing loops i.e. Gressing spring. - Difficult to control the position of the canines in all three planes of space, esp. vertical → not fail safe. - Added complexity and increased tx time makes skeletal anchorage more appropriate.

4. Retraction with skeletal anchorage	<ul style="list-style-type: none"> - Risk of excessive incisors retraction → aesthetic ↓ - <u>Maxilla:</u> <ul style="list-style-type: none"> - Ultimate reinforcement of anchorage, used to avoid 2-step space closure. - Bone screws in the palate or individual bone screws in the alveolar process. - Direct anchorage: Upward & backward direction of the pull. - Indirect anchorage: Force direction parallel to the occlusal plane - 22-Slot: Sliding along a 19x25 ss with an A-NiTi coil spring. - 18-Slot: Bone screws to stabilize the posterior segment while closing the extractions spaces with loop mechanics. - Evidence: <ul style="list-style-type: none"> o <i>Lagrange, 2010 & Sandler, 2014:</i> Alveolar bone screws are not more effective than a Nance appliance. (both moderate) o Palatal screws are effective to avoid molar mesialization during incisor retraction (Lee, 2013), esp. when 2 screws are used (Hourfar, 2015). - <u>Mandible:</u> - Locations for skeletal anchorage: <ul style="list-style-type: none"> o Bone screws in the alveolar process. o Bone screws in front of the ramus. o Anchors placed vertically into the buccal projection of the mn body below the molars. - Bone screws in the alveolar process in the mn & mx are probably comparable. (ø evidence) - Mn bone screws in front of the ramus can be compared with mx screws in the palate. (ø evidence) - Long screw in the ramus are more invasive.
Minimum incisor retraction Lückenschluss C	<ul style="list-style-type: none"> - Incorporate as many teeth in the anterior anchor unit as possible. - Extract rather the 2nd than 1st premolar: → The amount of incisor retraction will be less, the further posterior in the arch an extraction space is located. - Place an active lingual root torque in the incisor section: Preventing the incisors crowns from tipping forward tends to pull the posterior teeth forward. (=Row-bow-effect). Note: Anti-row-boat effect: Incisors are pulled back (tip back molar + arch length secured)  <ul style="list-style-type: none"> - Break down the posterior anchorage: Moving the posterior teeth forward one by one at a time. - Skeletal anchorage with bone screws in either arch in the canine region = easiest and most effective way esp. if more forward movement is needed on one side than the other.

Proffit Chapter 17:

Comprehensive Treatment: Finishing

- Begg technique:

- Major root movements of the anterior & posterior teeth had to be done with auxiliary springs, after closing the extraction spaces.
- Auxiliary springs are augmented with rectangular archwires in the modern Begg technique with tip-edge brackets.

- Edgewise technique:

- Adjustment of individual tooth positions to get the marginal ridges leveled.
- Precise in-out positions of the teeth.
- Overcome errors produced by bracket placement or the appliance's prescription.
- Alter the vertical relationship of the incisors if necessary.

- Sequence of arches in modern edgewise technique:

- Use the most efficient archwires to minimize clinical adjustments and chair time.
- Necessity to fill (or nearly fill) the bracket slot in the finishing stage with appropriately flexible wires to take full advantage of modern appliances.

22-Slot Appliances

Nonextraction

16 A-NiTi
16 steel (accentuated/reverse curve)
18 steel (accentuated/reverse curve)
21 × 25M-NiTi
21 × 25 beta-Ti

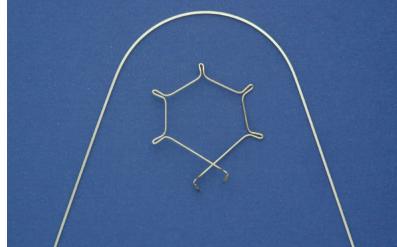
Extraction

16 A-NiTi
16 steel (accentuated/reverse curve)
18 steel (accentuated/reverse curve)
19 × 25 steel, A-NiTi coil springs
or 18 × 22 steel T-loop or 19 × 25 beta-Ti delta loop
21 × 25M-NiTi (if roots displaced, usually needed)
21 × 25 beta-Ti

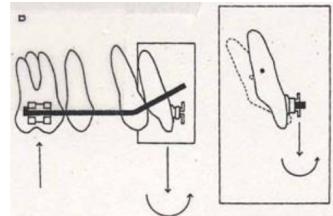
For a typical adolescent patient with malocclusion of moderate severity.
(Wire sizes in mil.)

Adjustment of individual tooth position	
<ul style="list-style-type: none"> - Some final adjustments are necessary to compensate for the individual tooth anatomy and mistakes in bracket positioning. - Poorly positioned bracket → usually it is more time-efficient to rebond the bracket rather than place compensating bends in the archwires (esp. if the inclination is not correct). - Use a flexible wire after rebonding a bracket. Rectangular wire = too stiff in bending for tooth positioning. - Minor in-out and up-down adjustments (to correct canine interdigitation / level out marginal ridges) can be obtained by placing mild step bends in a flexible full-dimension wire (next to the last wire in a sequence). Steps must be repeated in the final wire for torque adjustment. - NiTi archwires: Not recommended for torque expression → no effective torsional properties. - The position of a step bend is not critical. No difference whether a step bend is in the center of the interbracket span or offset to either side. 	
Midline discrepancies	<ul style="list-style-type: none"> - Reflect how the posterior teeth fit together. - Esthetically it is undesirable to displace the mx midline to meet a displaced mn midline. - Skeletal asymmetry: An orthodontic correction is maybe impossible. → Consider camouflage vs. surgery. - Elastic force: <ul style="list-style-type: none"> • Asymmetric cl.II/III elastic force: More effective if used bilaterally with heavier force on one side than placed only unilateral. • Diagonal elastics anterior only for small discrepancies. (otherwise risk for an occlusal cant due to elastic side effects) - Place coordinated steps in the archwires to shift the teeth of one arch more than the other. - A mn shift can occur if a slight discrepancy in the transversal position of posterior teeth is present → use a force system to correct the transversal relationship. (coordination of the dental arches, posterior cross-elastics)
Tooth size discrepancies	<ul style="list-style-type: none"> - <i>Othmann, 2007:</i> 2-mm tooth size discrepancy noted from Bolton analysis is the threshold for clinical significance. - A small space distal 2+2 can be functional & esthetically acceptable. - <u>Stripping:</u> <ul style="list-style-type: none"> • To compensate for excessive tooth size. • If part of the original tx plan, it should be done initially. • Defer final stripping until the finishing stage → direct observation of the occlusal relationship is possible before the final tooth size adjustments are done. • Apply topical fluoride immediately after stripping. - <u>Composite resin built-ups for small incisors:</u> <ul style="list-style-type: none"> • The root position must be correct before any restorations are done. • Precise finishing is easier if the built-up is done during the finishing stage. • If it is done after the appliance removal, any gingival inflammation should be healed. • Delay laminate restorations safter the end of orthodontic tx. (bonding can damage their surface) - <u>Mask small deficiencies by altering incisor position</u> <ul style="list-style-type: none"> • Torque: <ul style="list-style-type: none"> ○ Incisors slightly more upright makes them take up less room relative to the lower arch. ○ Slightly excessive torque can partially compensate for small upper incisors. • Slightly tip teeth. • Finish tx with mildly excessive OB/OJ.
Root paralleling	<ul style="list-style-type: none"> - Take an OPG towards the end of the 2nd stage of tx, to check for root positioning errors and root resorption. - <u>Begg technique:</u> <ul style="list-style-type: none"> • Auxiliary springs placed into the vertical slot of the Begg bracket (ribbon wise) and hooked beneath the archwire. • Crowns must be tied together across extraction sites, since root-paralleling forces are also crown separating forces. • Can be employed with the edgewise appliance if it includes a vertical slot behind the edgewise bracket.

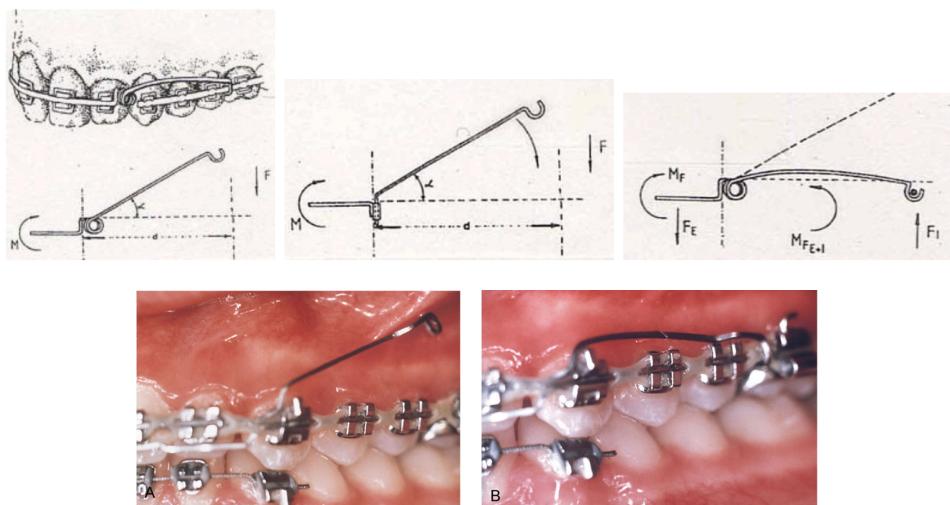


	<p>- 18 slot appliance:</p> <ul style="list-style-type: none"> • Finishing archwires: 17x22 ss or 17x25 ss. • The wires generate the necessary root paralleling moments + the wires are flexible enough to engage into narrow brackets. • If greater tipping is present, more flexible full-dimension rectangular archwires are needed: 17x25 TMA or 17x25 M-NiTi. <p>- 22 slot appliance:</p> <ul style="list-style-type: none"> • Usually less need for root paralleling than with the 18 slot. • Finishing arch: 21x25 TMA. Ss is too stiff. • If sign. root positioning is needed: 21x25 M-NiTi before TMA. <p>- Appropriate stiffness and relatively small deflection wire characteristics are more important in the finishing stage than the range.</p> <p>- If a severe tipped tooth is present and a longer range of action is needed: → Rectangular A-NiTi is indicated initially or an auxiliary Burston root uprighting spring if the brackets have a vertical slot (similar to an R-loop welded on the base arch which bypasses the tooth with need for correction)</p> <p>- Prevent crown separation during root paralleling:</p> <ul style="list-style-type: none"> • Tie all the teeth together or • Tie the entire archwire back against the molars. • Maxillary spaces are likely to open between the incisors in non-ex & ex cases if a full-dimension rectangular wire is placed. 
<p>Torque:</p> <p>- Lingual root torque of incisors</p>	<p>- Crowns are pushed labially with a torqueing force to move the roots lingually → Anchorage is needed to maintain the OJ when the upper incisors are torqued lingually → Class II elastics.</p> <p>- Piggyback arch:</p> <ul style="list-style-type: none"> • = Auxiliary arch to provide torque by creating a couple with a moment arm of 4-5 mm. • Bent into a tight circle initially: → Exerts a force against the roots of the teeth when it is partially straightened out to normal arch form and hooked behind the first premolars. The vertical parts point towards the occlusion and lie in the interdental space. The horizontal parts contact the labial surface of the incisors near the gingival margins  <p>- 18 slot appliance:</p> <ul style="list-style-type: none"> • 17x25 ss • Assumed that the rectangular archwires for finishing fits tightly into the bracket slot. <p>- 22 slot appliance:</p> <ul style="list-style-type: none"> • Full dimension M-NiTi or beta-Ti archwires for torquing incisors. The best finishing wire is usually 21x25 beta-Ti. Alternative: The stiffest braided ss 21x25 wire (braided ss wires are available in various stiffnesses). • Solid 21x25 ss is too stiff and results in high forces and a short range of action. • Some prescriptions have extra built in torque to compensate for rectangular finishing archwires that have more clearance. • Full torque expression is never achieved with undersized wires without extreme bracket prescriptions or placing major twist bends in the wires. (even then it is difficult to obtain adequate torque)

- Torquing arch:
- Indicated if all four incisors need torque.
 - Wire from the molar auxiliary tube to the incisors with a V-bend, so that the incisor segment receives a greater moment.
 - **Isacsoon 1993: 16x22 ss with 1.5 helices or TMA.**
(similar to an intrusion base arch, but with the V-bend more anterior closer to the incisor segment)



- Burston torquing arch:
- Long lever arm:
 - **Full-dimension ss (21x25)** that fits only into the brackets 1+1 or 21+12.
(Note: Bantleon, 1988: 17x25 TMA or ss, 18 slot)
 - Passive form: Posterior arm is up in the buccal vestibule.
 - Activated form: Hooked beneath the base arch archwire mesial to the first molars.
 - **Full dimensional rectangular stabilizing segments from the canines to the 1st molars.**
 - **Auxiliary wire 17x25 TMA from the molar:** -
Huckepack on premolars and canine brackets - step down to rest against the labial surface incisal to the brackets of the teeth which are going to be torqued. Must be tied back.
→ Prevents elongation and proclination of the incisors.



- Factors determining the amount of torque, which will be expressed by any rectangular archwire in a rectangular slot:
- Torsional stiffness of the wire.
 - Inclination of the bracket slot in relation to the archwire.
 - Tightness of the fit between the archwire and the brackets.

Semetz, 1993

TABLE 17.1 Effective Torque

From Semetz. *Kieferorthop Mitteil.* 1993;7:13–26.

Wire Size	Play (Degrees)	BRACKET TORQUE ANGLE (DEGREES)		
		10	22	30
		EFFECTIVE TORQUE		
18-Slot Bracket				
16 × 16	10.9	0.0	11.1	19.1
16 × 22	9.3	0.7	12.7	20.7
17 × 25	4.1	5.9	17.9	25.9
18 × 18	1.5	8.5	20.5	28.5
18 × 25	1.0	9.0	21.0	29.0
22-Slot Bracket				
16 × 22	21.9	0	0.1	8.1
17 × 25	15.5	0	6.5	13.5
19 × 25	9.6	0.4	12.4	20.4
21 × 25	4.1	5.9	17.9	25.9
21.5 × 28	1.8	8.2	20.2	28.2

Based on nominal wire and/or slot sizes; actual play is likely to be greater.

Torque: - Buccal root torque of premolars and molars	<ul style="list-style-type: none"> - Change bracket prescription to decrease or eliminate negative torque for mx canines and premolars. - <i>Zachrisson, 2002:</i> Reduced lingual crown torque gives the appearance a broader smile without the risk of relapse accompanying arch expansion. - Uprighting premolars elongates their lingual cusps: → Can lead to occlusal interferences, which are difficult for the patient to tolerate. → Reduction of the height of lingual cusps indicated.
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Correction of the vertical incisor relationship	
Excessive OB	<ul style="list-style-type: none"> - Evaluation of: <ul style="list-style-type: none"> • Vertical relationship between the mx lip and the mx incisors. • Anterior face height. → Defines if the anterior or posterior teeth should be corrected by extrusion or intrusion. - <u>Intrusion of mx incisors:</u> <ul style="list-style-type: none"> • If a rectangular finishing arch is in place, cut it distal 2+2 and install an auxiliary intrusion arch. • A stabilizing TPA is maybe needed to control the transverse relationship and prevent excessive distal tipping of the molars. - <u>Elongation of posterior teeth:</u> <ul style="list-style-type: none"> • Step bends in a flexible archwire are satisfactory.
Anterior open bite	<ul style="list-style-type: none"> - Evaluation of: <ul style="list-style-type: none"> • Vertical relationship between the mx lip and mx incisors. • Anterior face height. → Defines if the anterior or posterior teeth should be corrected by extrusion or intrusion. - Skeletal anchorage = Most effective approach for intrusion of posterior teeth. - If an open bite is due to an excessively leveled lower arch: <ul style="list-style-type: none"> • Elongate the lower, but not the upper incisors by installing a slight curve of Spee. • Put steps in an appropriately flexible lower archwire, while maintaining a stiffer upper wire supplemented with light vertical elastics. - Cl.II/III elastics have a bite opening effect which can be reduced by triangulation of the elastics. <div style="text-align: center; margin-top: 10px;">  </div> <ul style="list-style-type: none"> - Elongation of lower incisors to close a moderate anterior open bite: = Quite stable. - Elongation of upper incisors: = Less stable, compromises facial esthetics if it makes them too prominent.

Final “settling” of teeth	
<ul style="list-style-type: none"> - For a full-dimensional rectangular archwire it is not uncommon to hold some teeth slightly out of the occlusion. 	
Methods for settling	<ul style="list-style-type: none"> - <u>Light archwires:</u> Replace the rectangular archwires at the end of tx with light round archwires that provide some freedom for movement of the teeth. (16 mil in the 18-slot appliance, 16-18 mil in the 22-slot appliance) <ul style="list-style-type: none"> • The light final arches must include any 1st & 2nd order bends used in the rectangular finishing arches. • Combination with light vertical elastics to bring the teeth together is possible (usually not necessary) i.e. vertical triangles. • Let the wires only a few weeks in place. • Cave: Precise control of the anterior teeth is lost. - <u>Vertical elastics:</u> Remove the posterior segments of the archwires and use laced posterior vertical elastics for 1-2 weeks. <ul style="list-style-type: none"> • Cave: control of the posterior teeth is lost: → Contraindicated in patients with major rotations or posterior crossbites. - <u>Positioner:</u> Tooth positioner after debonding.
Control of rebound and posturing	<ul style="list-style-type: none"> - Rebound = Due only to tooth movement, 1-2 mm phenomenon. - Posturing = 4-5 mm relapse possible. - Teeth tend to go back towards their initial position after class II/III correction, especially if elastics have been used. → Slightly overcorrect the occlusal relationship. - Guidelines for finishing tx with interarch elastics: <ul style="list-style-type: none"> • Decrease the force while light elastics are continued full time for another appointment when an appropriate degree of overcorrection has been achieved. • At that point, discontinue interarch elastics 4-8 w before the appliances are removed. • If the occlusion is stable, the teeth should be brought into a solid occlusion relationship without heavy archwires present.
Removal of bands and bonded attachments	<ul style="list-style-type: none"> - <u>Bands:</u> <ul style="list-style-type: none"> • Break the cement, remove any rest by scaling. • Upper jaw: 1st lingual , then buccal. • Lower jaw: 1st buccal, then lingual. - <u>Metal brackets:</u> <ul style="list-style-type: none"> • Fracture between the bracket & resin (= usual failure site) or within the resin bonding material. • Bend the base of the bracket to prevent enamel damage. - <u>Ceramic brackets:</u> <ul style="list-style-type: none"> • Little ability to deform: → Shearing stress applied to the bracket to remove it can create alarmingly high forces. • Modify the interface between the bracket & bonding resin to increase the chance that the failure occurs at this level. • Use heat to soften the bonding resin: → Brackets can be removed with lower force. • Modify the bracket so that it breaks predictably when the debonding force is applied. • Enamel damage at debonding is more likely with ceramic than metal brackets. - 4% of patients have major enamel damage from bracket debonding. - Remove the rest of the resin with a 12-fluted carbide at moderate speed. - Apply topical fluoride after debonding, because the fluoride rich outer enamel layers are probably lost, even with a careful approach. - Remove the rest of ceramic brackets with a diamond bur.

TABLE 17.2 Enamel Presence on Debonded Brackets

Summarized from Cochrane NJ, Lo TW, Adams GG, Schneider PM. *Am J Orthod Dentofac Orthop.* 2017;152:312–319.

	METAL BRACKETS	CERAMIC BRACKETS		
		Two-Step Etch-and-Bond n = 150	Two-Step Etch-and-Bond n = 144	Self-Etching Primer n = 126
% Presence of enamel	13.3	30.2	38.2	19.7
% Bracket fracture	0	26.2	6.2	12.1
<i>RMGIC</i> , Resin-modified glass ionomer cement.				

Positioners for finishing

- Indications:
 - Gingival condition with more than the usual degree of inflammation and swelling at the end of active orthodontic tx.
→ Gingival massage supports the healing process.
 - Open bite tendency so that settling by mild depression rather than elongation of posterior teeth is needed.
- Most effective if placed immediately after removal of the fixed appliance.
- Tooth movement tends to decline rapidly a few days after debonding:
→ Apply the positioner directly after debonding, wear it full time the first 2 days and afterward at least 4h during the day + during sleep.
- Positioner produces any changes it is capable of within 2-3 w.
→ After that, it serves more as a retainer than a finishing device (bad retainer function!).
- Fabrication:
 - Remove the archwires 4-6 w before the planned removal of the appliance.
 - Use a facebow transfer to mount the casts.
 - All erupted teeth should be included to prevent supereruption.
 - Bands & brackets are trimmed away, any band space is closed.
 - Tth are individually positioned with high precision in the lab.
 - Positioners are formed of an elastic material with the characteristic to move the teeth slightly to their final positions as the patient bites into it.
- Advantages:
 - Fixed appliance can be removed somewhat more quickly.
 - It massages the gingiva apart from repositioning the teeth.
→ Gingival stimulation is an excellent way to promote rapid return to normal gingival contours.
- Disadvantages:
 - Expensive.
 - Tends to increase OB more compared to settling with vertical elastics.
 - Does not maintain the position of rotated teeth well.
 - Good cooperation is essential.

Special finishing procedures to avoid relapse	
Control of unfavorable growth	<ul style="list-style-type: none"> - Requires a continuation of active tx after the fixed appliance has been removed: <ul style="list-style-type: none"> • Continued EO force in conjunction with orthodontic retainers. • Use a functional appliance rather than a conventional retainer after the completion of fixed appliance tx.
Control of rebound after tooth movement	<ul style="list-style-type: none"> - A major reason for retention is holding the teeth until soft tissue remodeling can take place. - Even with the best remodeling, some rebound from the application of orthodontic forces occurs. 2 strategies to deal with it: <ul style="list-style-type: none"> - 1. Overtreatment: <ul style="list-style-type: none"> • Only a small degree of overtx is compatible with precise finishing. • Class II/III: <ul style="list-style-type: none"> ◦ Overcorrect 1-2 mm. ◦ Elastic wear can be reinstated to obtain a complete correction if there is excessive rebound. • Crossbite correction: Overcorrect minimum 1-2 mm. • Crowded and irregular teeth: <ul style="list-style-type: none"> ◦ Often not stable. ◦ Overcorrect it in the 1st stage of tx and stabilize it for some months. ◦ No overcorrection in the rectangular finishing archwires. • Rotation corrections: <ul style="list-style-type: none"> ◦ Perform overcorrection and maintain it as long as possible by adjusting the wings of single bracket or by maintaining a rotation wedge in place with twin brackets. Position of rotation wedge = incisal & cervical wings of the side of the tooth which should be lingual rotated. Elastic tie only on the other wings without the rotational wedge. ◦ Later periodontal procedures are often necessary to improve stability. - 2. Adjunctive periodontal surgery: <ul style="list-style-type: none"> • The network of elastic supracrestal gingival fibers is a major cause for rebound: → Relapse is greatly reduced by sectioning these fibers and allow healing while the teeth are held in proper position. • Circumferential supracrestal fibrotomy CSF: (<i>Edwards, 1988</i>) <ol style="list-style-type: none"> 1. Local anesthetic. 2. Insert the sharp point of a fine blade into the gingival sulcus down to the crest of alveolar bone. 3. Cuts are made interproximal on each side of a rotated tooth and along the labial and lingual gingival margins unless they are quite thin. 4. No periodontal pack necessary, only minor discomfort after the procedure. <p>Alternative: Use a lase instead of a blade.</p> • Papilla dividing procedure (alternative approach): <ol style="list-style-type: none"> 1. Incision in the center of each gingival papilla, sparing the margin but separating the papilla from just below the margin to 1-2 mm below the height of the bone buccal & lingual. <p>→ This approach should reduce the possibility of vertical attachment loss after surgery (no evidence).</p>



Micro-esthetic procedures in finishing	
Recontouring the gingiva to improve tooth proportions and display	<ul style="list-style-type: none"> - Height-width ratios of the teeth are greatly affected by the extent to which the gingiva covers the upper part of the crown. - Soft tissues considerations should be dealt first with, before reshaping the teeth. - Provide enough time for healing. - Soft tissue recontouring allows ideal vertical placement of brackets. - Remove any excess of soft tissue with laser after checking the probing depth.
Reshape the teeth for enhanced esthetics	<ul style="list-style-type: none"> - Enameloplasty should be deferred until initial alignment has been achieved and rotations corrected = end of the finishing stage of tx. (Rotations influence the perception of the width.) - Important elements: <ul style="list-style-type: none"> • Ideal ratios of tooth dimensions • Tooth shape and contours • Ideal width-length relation 1+1: 0.8 (average length 1+1 = 11.7 mm) - Connector length between 1+1: Ideal 50% of their length. - Temporary restorations so that all teeth have approximately the correct size makes finishing easier.

Proffit Chapter 18:

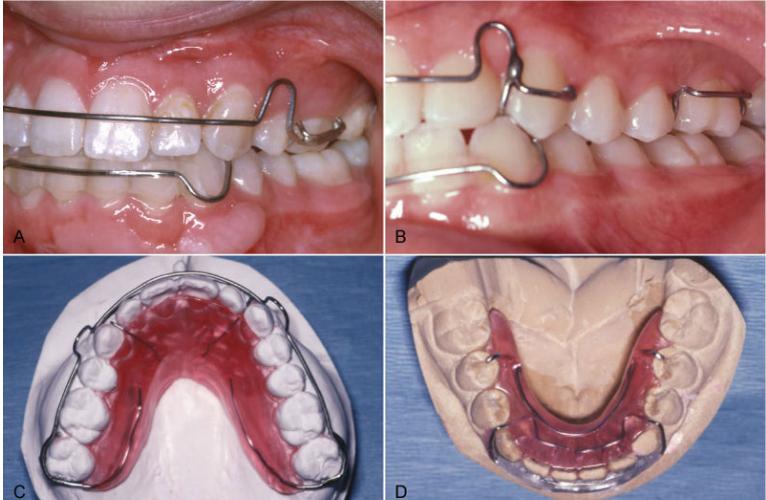
Retention

Why is retention necessary?
<ul style="list-style-type: none">- Orthodontic tx results are potentially unstable.- Factors influencing long-term results: (<i>Ormiston, 2005 / Joondeph, 2017</i>)<ul style="list-style-type: none">o Gendero Post-tx growtho Type of malocclusiono Magnitude of the pre-tx irregularityo Quality of the orthodontic tx- Reasons why retention is necessary:<ul style="list-style-type: none">• The gingiva and periodontal tissues are affected by orthodontic tooth movement and require time for reorganization when the appliances are removed.• The teeth will be in an inherently unstable position after the tx. → Soft tissue pressure constantly produces a relapse tendency.• Changes produced by growth may alter the orthodontic tx results.- Gradual removal of the orthodontic appliance is of no value → relapse or permanent retention is necessary.- Retention cannot be stopped before growth is completed.
Reorganization of periodontal and gingival tissues
<ul style="list-style-type: none">- The periodontal ligament space widens and collagen fiber bundles are disrupted during orthodontic tx.- Restoration of the normal periodontal architecture does not occur as long as a tooth is strongly splinted to its neighbors (i.e. a rigid archwire).- Bone bending as each tooth is displaced slightly relative to its neighbors when the patient chews, is necessary for recovery from the splinting effect of a fixed appliance.- If the teeth can respond individually to the forces of mastication, reorganization of the periodontal ligament occurs over 3-4 m.- Small but prolonged imbalances in tongue-lip-cheek pressure or pressure from the gingival fibers are resisted by active stabilization due to PDL metabolism (same force-generating mechanism that produces eruption). → The disruption of the PDL produced by orthodontic tooth movement eliminates this active stabilization. (but has probably little effect on stabilization against occlusal forces). → Directly after orthodontic tx, teeth are maybe unstable against occlusal and soft tissue pressure, which can be resisted later.
<p>The major causes of relapse after orthodontic treatment are elastic recoil of gingival fibers, which can cause intra-arch irregularity; cheek/lip/tongue pressures, which can affect both tooth alignment and occlusal relationships; and differential jaw growth, which can change occlusal relationships. Gingival fibers and soft tissue pressures are especially potent in the first few months after treatment ends, before PDL reorganization has been completed. Unfavorable growth is the major contributor to long-term changes in occlusal relationships.</p> <ul style="list-style-type: none">- Reorganization of the collagenous and the elastic fibers occurs more slowly than of the PDL itself:<ul style="list-style-type: none">• Collagenous fiber network completes its reorganization within 4-6 m. (<i>Reitan, 1959</i>)• Elastic supracrestal fibers remodel slowly and can still exert forces capable to displace a tooth 1 y after removal of the orthodontic appliance. (<i>Reitan, 1959</i>)- Severe rotations: Section of the supracrestal fibers around teeth initially or before the appliance removal is recommended. (high relapse tendency due to the elastic fibers)

Principles of retention against intraarch instability

- The teeth will tend to move back in the original directions because of elastic recoil of gingival fibers and unbalanced tongue-lip forces.
- Full time retention is required in the first 3-4 m after removal of the orthodontic appliances.
 - Patients will wear retainers about 12 h if instructed to wear them full time, but this is enough.
 - Ask for more, to be sure you get what you want.
- To promote reorganization of the PDL, the teeth should be free to flex individually during mastication, as the alveolar bone bends in response to heavy occlusal loads during mastication.
- Retention should be continued for at least 12 m if the teeth were quite irregular before tx, due to the slow response of gingival fibers. The time of wearing the retention appliance can be reduced after 3-4 m.
- After 12 m, it should be possible to discontinue retention in non-growing patients. Gradual discontinuation helps to test the stability.
- In the absence of growth, the teeth should be stable by 1-2 y after tx, if they will ever be.
- Some patients who are not growing require permanent retention to maintain teeth in an unstable position with higher soft tissue pressure than the force provided by active stabilization.
- Growing patients usually need retention until growth has reduced to the low levels of adult life.

Occlusal changes related to growth	
<ul style="list-style-type: none"> - Skeletal problems in all 3 planes tend to recur if growth continues (the original growth pattern continues). - Behrents, 1984: Very slow growth continues throughout adult life (vertical > anterior-posterior > transversal). 	
Retention after class II corrections	<ul style="list-style-type: none"> - Relapse = Combination of tooth movement and differential growth. - Overcorrect the occlusal relationship 1-2 mm anterior-posterior. → Changes caused by adjustments in tooth position are likely to occur after tx, esp. if class II elastics were used. - Don't move lower incisors > 2 mm forward. → Lip pressures will upright them if no permanent retention is applied → crowding. - The more severe the initial cl.II occlusion and the younger the patient at the end of active tx, the more likely the need for a retention appliance. - <u>Appliances:</u> <ul style="list-style-type: none"> • HG on 6+6 2/4 + retainer to hold the alignment. • Functional appliance of an activator-bionator type to hold tooth positions and the occlusal relationship. <ul style="list-style-type: none"> ◦ Construction bite without any mn advancement if there is no excessive OJ. ◦ In a deep bite patient, the acrylic over the lower posterior teeth can be trimmed away, so that these teeth can erupt slightly while the other teeth are tightly controlled.
Retention after class III corrections	<ul style="list-style-type: none"> - Continuing growth of the mandible is very likely to occur and difficult to control. - Surgical correction often is the only solution, if growth has expressed itself for patients with normal or excessive lower face height. - Mild cases: <ul style="list-style-type: none"> ◦ Chin cup tends to rotate the mandible downward. → Growth is expressed more vertically and less horizontally. ◦ Positioner to maintain the dental relationship.
Retention after deep bite corrections	<ul style="list-style-type: none"> - Control of the vertical overlap of incisors is required for most patients. - Cave: Vertical growth continues until late teens → long retention period needed. - <u>Appliances:</u> <ul style="list-style-type: none"> • Removable upper retainer: The lower incisors encounter the baseplate if they begin to slip vertically behind the upper incisors. The retainer does not separate the posterior teeth.
Retention after anterior open bite corrections	<ul style="list-style-type: none"> - Anterior open bite can occur by depression of the incisors or elongation of the molars - Stop active habits: Thumb sucking... - Tongue-thrust swallowing: No evidence to be a reason for relapse of open bites. - Elongation of upper molars = Mostly the reason for the relapse of an open bite if no habits are present. → The molar eruption must be controlled! - Cave: Vertical growth continues until the late teens → long retention needed. - <u>Appliances:</u> <ul style="list-style-type: none"> • Bite blocks (modified Hawley retainer) between the posterior teeth to create some mm jaw separation → soft tissue is stretched = force opposing eruption. • High pull HG • Vacuum formed retainer with thickened plastic over the posterior surfaces? (no good data exists)
Retention of lower incisor alignment	<ul style="list-style-type: none"> - Forward-downward growth of the mandible / posterior rotation of the mandible: → Lower incisors are carried into the lip. → Distal tipping force generated (esp. cl.III, open bite). - Retainer for retention until growth of the mandible decreases to adult levels. - Pressure from 3rd molars as a reason for incisor crowding is incorrect. - Evidence is contradictory if the post-tx crowding can be predicted from characteristics of the original malocclusion or variables associated with tx. → To be sure, place fixed retainers in every patient.
Timing of retention: Summary	<ul style="list-style-type: none"> - Retention is needed for ALL patients. - First 3-4 m: Removable retainers 4/4 except for eating or fixed retainers that are flexible enough to allow displacement of individual teeth during mastication. (unless periodontal bone loss or other special circumstances require permanent splinting) - Continuation of the retainer on a part-time basis for 12 m to allow time for remodeling of gingival tissues. - Continue part time wear of retainers, if significant growth remains. - In case of skeletal problems pre-tx: Functional appliance or EO-force part time needed.

Removable retainers	
<ul style="list-style-type: none"> - Serve for intra-arch or inter-arch stability and are useful in patients with growth problems. - If permanent retention is needed → Prefer fixed retention. 	
Hawley retainers	<ul style="list-style-type: none"> - Adam clasp on the first molars. - Outer bow with adjustment loops usually from canine to canine. - Covers the palate → potential bite plan to control an increased pre-tx OB. - Difficult to keep extraction spaces closed with the standard model. <p>- <u>For extraction cases:</u></p> <ul style="list-style-type: none"> • Bow soldered to the buccal section of the Adams clasps. (A) → Activation of the bow helps to hold the extraction sites closed. • Wrap around outer bow soldered to C-Clasp on the 2nd molars: (C) → No interference as the wire crosses the occlusion. → Cave: Bow quite flexible due to the long span. <p>- <u>Control of buccally positioned canines:</u> (B) A wire to an anterior bow (that crosses distal the lateral incisors) and which extends across the canines.</p> <ul style="list-style-type: none"> - A clear outer bow (D) fits more tightly than a metal wire and is better esthetically. → Cave: No adjustments are possible. - Slightly trimming the acrylic lingual to the posterior teeth so that an eruption path exist is an important clinical adjustment. - Wires from clasps crossing the occlusal table can disrupt the tooth relationship: → If the occlusion is tight, chose a circumferential clasp on the terminal molar. 
Wraparound (clip) retainers	<ul style="list-style-type: none"> - Plastic bar (usually wire reinforced) along the labial and lingual surfaces of the teeth. - Indication: Prevent spaces from reopening. <p>- Advantages:</p> <ul style="list-style-type: none"> • Esthetic. • Spaces are impeded from reopening. • Prevents re-rotations. • Can be used to realign irregular incisors in a mild crowding situation. • For a mn retainer, the Hawley bow is less effective than a wire reinforced acrylic bar that tightly contacts the lower incisors. <p>- Disadvantages:</p> <ul style="list-style-type: none"> • Not very comfortable. • No individual tooth movements for reconstruction of the PDL are possible if a full-arch retainer is applied. → Fullarch retainer is indicated only for splinting if a periodontal breakdown is present) • Undercuts lingual to the lower molars make it difficult for posterior extensions. • If applied in the upper arch, contact of the lower incisors can become a problem. • May not effective in maintaining OB correction.

	<p>- Moore retainer:</p> <ul style="list-style-type: none"> o = Canine-to-canine wraparound retainer extended distally on the lingual side only to the central grooves of the first molar o Indicated in lower extraction cases.
Clear (vacuum-formed) retainers	<ul style="list-style-type: none"> - Invisible. - <i>Tynelius, 2010 & 2015:</i> No difference regarding the effectiveness to maintain the alignment between vacuum-formed retainers and bonded wire retainers, but excellent compliance is needed. - Disadvantages: <ul style="list-style-type: none"> • Thickness of the material over the occlusal surface on the teeth can become a problem <ul style="list-style-type: none"> o Separation of the posterior teeth may develop. o <i>Mai, 2014:</i> <ul style="list-style-type: none"> ▪ Posterior occlusion is better at 6 m after debonding with a Hawley retainer than a vacuum-formed retainer for just the mx arch. No difference however at a long-term recall. ▪ Better occlusion with mx vacuum-formed retainer and mn fixed retainer than with a mx and mn vacuum-formed retainer. o → Small holes can be made in the occlusal surface of the retainer at the points of occlusal contacts. • Does not help to control a deep bite. • Tend to crack and discolor after a few months (~9 m). • Use of the final aligner in an Invisalign sequence as a retainer is not as effective as use of another vacuum formed retainer, because a thinner and less durable material is used.
Positioners as retainers	<ul style="list-style-type: none"> - Indication: <ul style="list-style-type: none"> o Open bite patients. o Cl.III patients → Mn is rotated somewhat downward and backward. o If used as a finishing device before. - Not advised as routine retainer: <ul style="list-style-type: none"> • Bulky → difficult to wear full time. • Retention of incisor irregularities and rotations is not as well as with standard retainers. • OB tends to increase. - Maintains the occlusal relationship and intra-arch tooth positions. - Less effective in controlling growth than a functional appliance or a HG worn 2/4. - Articular mounting in difficult cases is necessary when posterior teeth are separated 2-4 mm.

Fixed retainers	
Indications	<ul style="list-style-type: none"> - Normally used when inter-arch instability is anticipated and prolonged retention is planned. - Enough movement of the mn incisors to promote maturation of the supporting bone is important. - <u>1. Maintenance of lower incisor position during late growth:</u> <ul style="list-style-type: none"> • Canine to canine bonded: 28 or 30 ss <ul style="list-style-type: none"> ◦ Rests against the lingual surfaces of the incisors above the cingulum to prevent them from lingual moving. ◦ The wire must be heavy enough to resist distortions. ◦ Place a loop at the end of the wire to improve retention. ◦ <i>Booth, 2008:</i> No periodontal problems in 20 y observation time. 61% survival. • Bonded on all teeth: 17.5 braided steel <ul style="list-style-type: none"> ◦ Indicated if severe rotations were present. ◦ If the span of the wire is reduced, a more flexible wire should be used. ◦ Controls are necessary: Bond failure is unlikely to be noticed by the patient + risk for decalcifications. ◦ <i>Al-Nimri, 2009:</i> Plaque build-up ↑ for a mn multistranded wire vs. a heavier round wire bonded to canines only, but effectiveness to maintain alignment ↑ - <u>2. Diastema maintenance:</u> <ul style="list-style-type: none"> • Tendency for space opening between 1+1 even with frenectomy. • Wire can be configured to avoid tooth contact or facilitate flossing and can incorporate stops to prevent deepening of the bite. - <u>3. Maintenance of a pontic or implant space:</u> <ul style="list-style-type: none"> • Implants should be placed as soon as possible after the orthodontic tx is completed. → The integration of the implant occurs simultaneously with the initial stages of retention. • Heavy wire bonded to the adjacent teeth: <ul style="list-style-type: none"> ◦ The longer the span, the heavier the wire should be. ◦ Bringing the wire down out of occlusion, decreases the chance that it will be displaced by occlusal forces. • Replacement teeth in the anterior part can be attached to a removable retainer. Prefer a bonded bridge if retention is required for a longer period. - <u>4. Keeping extractions spaces closed in adults:</u> <ul style="list-style-type: none"> • Fixed retainer on the facial surface of posterior teeth indicated, esp. if skeletal anchorage has been used.

Inadvertent tooth movement with fixed lingual retainers	<ul style="list-style-type: none"> - Loss of lower incisor alignment is more likely when wires break: → Breakage increases the likelihood that the wire is distorted at the same time and leads to activation of the wire. - Downward deflection of the wire could occur if bond failures of the incisors occur, but the canines remain bonded. - Displacement of the crowns is as likely as inadvertent torque forces. - Inadvertent torque forces may cause fenestration of the labial or lingual cortical alveolar bone. - Dead soft wire was suggested to be safer than flexible twist wire, but no evidence is available to support this.
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Active retainers	
Realignment of irregular incisors	<ul style="list-style-type: none"> - Indication = Realignment of irregular incisors. - The shapes of the incisors' crowns can contribute to a re-crowding (<i>Shah, 2003</i>), but in most cases mn growth that tips the incisors lingually causes the problem. - <u>Stripping:</u> <ul style="list-style-type: none"> • Often necessary before realignment of the incisors so that the crowns do not tip labially into an unstable position. • Reduces the amount of space required for alignment. • Flattens the contact areas → more stability in the corresponding region. (<i>Note: not believed at the ZMK</i>) • <i>Zachrisson, 2007:</i> Long-term periodontal health is not affected by the increase of root proximity. • <i>Zachrisson, 2011:</i> IPR has no adverse effect on the long-term stability of the teeth. • Lower incisors can be reduced up to 0.5 mm on each side. <i>Gillings et al. 1961:</i> <ul style="list-style-type: none"> • Mean thickness of mesial-incisal area: 0.62 mm (0.42 0.82 mm) • Mean thickness of distal-incisal area: 0.64 mm (0.44 0.84 mm) - <u>Appliances:</u> <ul style="list-style-type: none"> ○ A short series of aligners ○ Canine to canine clip: only for small/modest crowding situations <ol style="list-style-type: none"> 1. IPR 2. Realign the teeth in laboratory → clip on appliance ○ A fixed appliance is necessary if more crowding is present. 
Correction of occlusal discrepancies: Modified functional appliances	<ul style="list-style-type: none"> - Permanent retention is necessary after correction. - Indication = Management of Cl.II or cl.III relapse tendencies. - Can be used in teenagers but are of no value in adults. - Not > 3 mm of occlusal correction is possible. - Differential antero-posterior growth is not necessary to correct small occlusal discrepancies → Tooth movement is adequate. Some vertical growth however is required to prevent downward and backward rotation of the mandible. - Cl.II: Correction is achieved by restraining the eruption of the posterior maxillary teeth and directing the erupting mandibular teeth anteriorly. - Functional appliance used as a passive retainer: <ul style="list-style-type: none"> ○ Objective: Control growth. ○ Tooth movement is largely an undesirable side effect. - Functional appliance used as an active retainer: <ul style="list-style-type: none"> ○ Expected primarily to move teeth. ○ No significant skeletal changes are anticipated.

Discussion with Dr. Gkantidis 09.05.2017

- *Little, 1995:*
Observational study from 21-35 y:
80% of patients have incisor crowding after orthodontic treatment without retention.
- First 6 m after orthodontic tx = most crucial time for retention.
- 1-2 y after tx it is no longer retention, but prevention of normal tooth movement.
- Lower incisors: High risk for relapse.
- Upper incisors: Low risk for relapse but positioned in the high important esthetic region.
- Use essix retainers in both jaws for retention of an anterior open bite.
→ Same bite closing effect like a positioner.

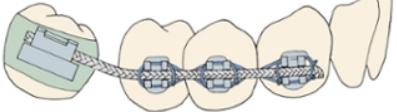
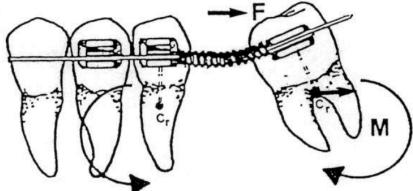
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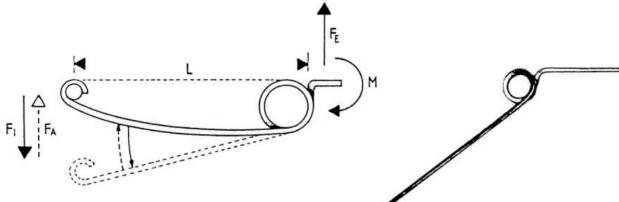
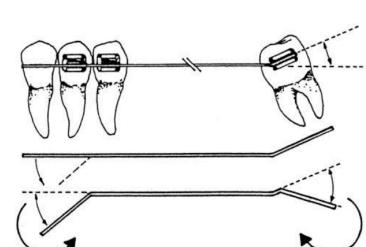
Special Consideration in Treatment for Adults

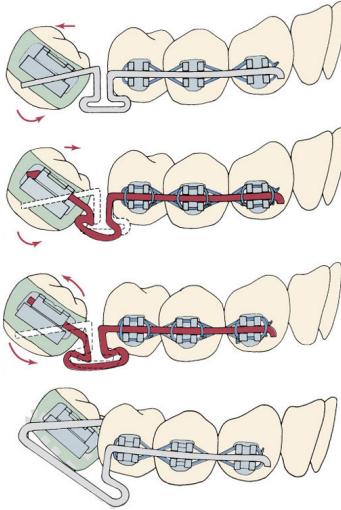
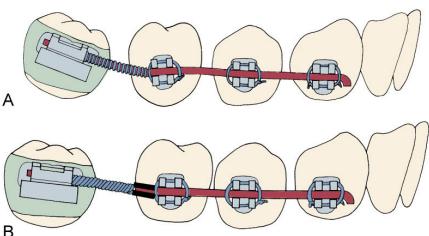
Adjunctive versus comprehensive treatment	
Differences in treating adult patients	<ul style="list-style-type: none"> - USA: 30% of orthodontic patients = adults. - Other types of dental tx, apart from orthodontics, are nearly always required compared to children. - Prevalence of orthodontic problems increase with age. - Used dentition. - Absence of growth: <ul style="list-style-type: none"> → No uncertainties about growth direction, but no growth modification is possible. → The whole tx must be done with tooth movement, restorative dentistry or orthognathic surgery.
Rules to consider	<ul style="list-style-type: none"> - Involve all the dentists who will play a role in the tx planning. - Diagnostic setup → = Diagnostic and communication tool for the patient. - Ideal dental occlusion and facial appearance are not necessary an appropriate tx goal: <ul style="list-style-type: none"> → Costs & risks / benefits to the patient. → Differentiate between a realistic tx focused on the patient's problem and an ideal tx aimed at perfection. - Adults younger than 35 y: Goal = Improve the quality of life. - Adults in their 40s/50s: Goal = Maintain what they have. Orthodontics is often an adjunctive procedure to larger periodontal or restorative goals. - More clinical time necessary for explanations. - Adults experience more pain / are less tolerant. <ul style="list-style-type: none"> → Medication for pain control is important. - Disease control is more often necessary.
Adjunctive treatment	<ul style="list-style-type: none"> - = Tooth movement carried out to facilitate other dental procedures, like to control disease / restore function and/or enhance appearance. - Involves usually only a part of the dentition. - Lasts usually a few months. - Long-term retention is usually supplied by the restorations. - Should be carried out within the context of a general dental practice. - Patients are typically in their 40s/50s.
Comprehensive treatment	<ul style="list-style-type: none"> = Same like for adolescents. Aim = produce the best combination of dental and facial appearance, dental occlusion and stability result to maximize the patient's benefit. - Duration > 1 y. - Often demand for esthetically enhanced appliances. - Should be provided by an orthodontic specialist. - Patients are often <35 y / 20s.

Principles of adjunctive treatment	
Goals of adjunctive tx	<ul style="list-style-type: none"> - Improve periodontal health by eliminating plaque-harboring areas and improving the alveolar ridge contour adjacent to the teeth. - Establish favorable crown-to-root-ratios and the position of the teeth so that occlusal forces are transmitted along the long axes of the teeth. - Facilitate restorative tx by positioning the teeth so that more ideal and conservative techniques can be used & optimal esthetics obtained. <p><u>Procedures:</u></p> <ul style="list-style-type: none"> - Repositioning of teeth that have drifted after extractions or bone loss, so that more ideal fixed or removable partial dentures can be fabricated or implants placed. - Alignment of anterior teeth for esthetic restorations or splinting while maintaining good interproximal bone contour and embrasure form. - Correction of crossbites if they compromise jaw function. - Forced eruption of badly broken-down teeth to expose sound root structure to place crowns or to level bone margins and regenerate alveolar bone.
Not part of adjunctive tx	<ul style="list-style-type: none"> - TMJ problems. - Intrusion of teeth because of technical difficulties and the possibility of periodontal complications. - Adults with periodontal involvement / bone loss & extruded incisors: Best treated by reduction of crown height. - Crowding > 3-4 mm should not be solved with IPR of the anterior teeth. → Better to perform IPR also posterior and correct the alignment with a full appliance.
Principles of adjunctive tx	<ul style="list-style-type: none"> - Restorative dentist usually is the principal one. - Diagnostic records needed for tx planning differ from those of children: <ul style="list-style-type: none"> o Individual intraoral radiographs to supplement the panoramic radiograph (required by the ABO except, if only a partial fixed appliance is planned). o Pre-tx lateral cephalometric view is usually not required for adjunctive orthodontics with a partial fixed appliance. o Articulator-mounted casts are often necessary. - Often need for fixed appliances or a sequence of aligners. (problem management is for most cases not possible with removable appliances). - Skeletal anchorage makes tx often more effective and efficient.
Characteristics of the orthodontic appliance	<ul style="list-style-type: none"> - 22-slot edgewise appliance with twin brackets recommended or clear aligners. - A fixed appliance is needed if root movement is planned for patients with reduced alveolar bone height to achieve the large moments required. - Brackets are placed in an ideal position only on the teeth indented to move. The remaining teeth can be bracketed and incorporated in the anchor system so that the archwire slots are closely aligned. → Anchorage segment of the wire can be engaged passively in the brackets with little bending. - Clear aligners: <ul style="list-style-type: none"> • Better esthetic → compliance ↑ • Control of the root position / correction of rotations & extrusion of teeth is difficult.
Timing and sequences	<ol style="list-style-type: none"> 1. Comprehensive tx plan 2. Disease control 3. Establishment of the occlusion 4. Definitive periodontal / restorative tx 5. Maintenance <ul style="list-style-type: none"> - Restorations requiring detailed occlusal anatomy should not be placed until any adjunctive orthodontic tx has been completed. - Surgical pocket elimination and osseous surgery can be delayed after the end of orthodontic tx because soft tissue and bony recontouring occurs during orthodontic tooth movement. - <i>Thilander, 1996:</i> Orthodontic tooth movement superimposed on bad periodontal health can provoke a rapid & irreversible breakdown of the periodontal support. - <i>Ogihara, 2010:</i> Orthodontic tx with both normal and compromised periodontal tissues can be completed without loss of attachment if there is good periodontal tx both initially and during tooth movement.

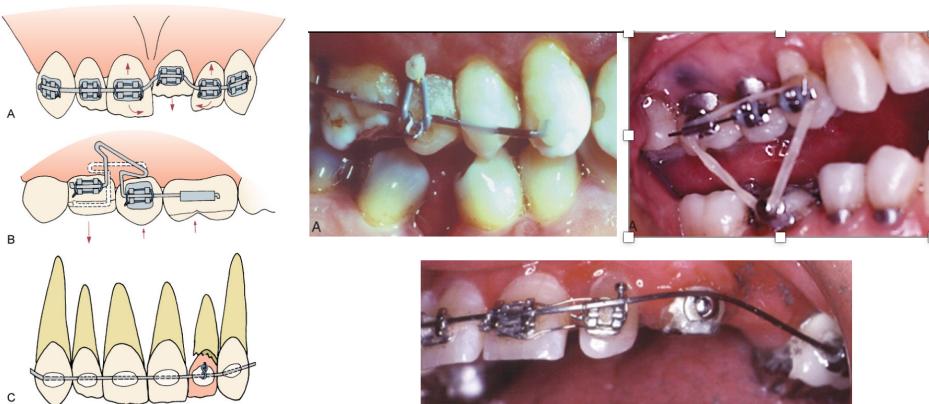
Effects of reduced periodontal support	<ul style="list-style-type: none"> - Bone loss → decrease of PDL area → same force against the crown produces greater pressure in the PDL compared to a normally supported tooth → Absolute magnitude of force used to move teeth must be reduced. - Attachment loss ↑ → center of resistance further apical (healthy tooth: 6/10 of the distance between the apex of the tooth and the crest of the alveolar bone) → Larger moments are created by force application to the crown. - Available anchorage ↓ → consider skeletal anchorage. - Permanent retention necessary. - If root movement is desired: Fixed appliances necessary to create the large moments needed. <p>Lighter forces and larger moments to control root movement are needed for tx.</p> $M_F = 200 \times 10 = 2000 \text{ gm/mm}$ $M_F = 200 \times 12 = 2400 \text{ gm/mm}$
Adjunctive treatment procedures: Uprighting posterior teeth	
Tx planning considerations after early loss of 1 st molar to upright a 2 nd molar	<ul style="list-style-type: none"> - If the 3rd molar is present: Distal positioning of the 3rd molar moves it to a position in which good hygiene cannot be maintained and there is no functional occlusion. → Extract 3rd molar, upright 2nd molar. - Tx by distal tipping of the 2nd molar is preferred to mesial root movement. → Root movement happens very slowly if extensive ridge resorption has occurred, but may eliminates the need for prosthesis. → Uprighting with space closure often requires temporary skeletal anchorage. - Uprighting a mesial tipped tooth also extrudes it: → Depth of the pseudopocket is reduced mesial. Attached gingiva follows the cementoenamel junction while the mucogingival junction remains the same → width of the keratinized tissue is increased. - Improved crown-root ratio if the height of the clinical crown is reduced. (routine part of molar uprightness).
Appliances for molar uprighting	<ul style="list-style-type: none"> - Tube or band on the molar, brackets on the premolars & canine bonded passively or active to move the teeth. - Bands are best when the periodontal conditions allows it. (bonded attachment on teeth with severe periodontal breakdown)

<p>Uprighting a single molar:</p> <p>1. Distal crown tipping</p>	<ul style="list-style-type: none"> - <u>Moderately tipped molars</u> <ul style="list-style-type: none"> • Flexible rectangular wire (17x25 A-NiTi), 100 gm force • Braided rectangular steel wire as alternative. Often removal and reshaping required. • The occlusion must be relieved while the tooth tips upright.  <ul style="list-style-type: none"> - <u>Druckfeder:</u> <p>Druckfeder: Druckfeder um 1/3 der ursprünglichen Länge komprimieren</p> <p>Kl.III Geometrie</p>  <p>Molaren: Drehmoment der Geometrie und der Stoßfeder addieren sich. Extrusion.</p> <p>Verankerungssegment: Drehmomente gegenläufig. Intrusion über viele Zähne verteilt.</p> <p>Attachment im Kronenbereich -> Translation und Rotation; die Kraft der Stoßfeder bewirkt ein Drehmoment, dazu kommen Drehmomente vom einligierten geraden Draht (Burston III), dadurch entstehen die vertikalen Kräfte (Extrusion des Molaren, Intrusion PM)</p> <p>Ind: Lücken im PM – Bereich, distal abgewanderte PM Kontraind: Protrudierte Frontzähne</p> <ul style="list-style-type: none"> - <u>Severely tipped molars:</u> <ul style="list-style-type: none"> • Use a sectional spring to prevent side effects on the premolars. 1. Preliminary alignment of the anchor teeth, 19x25 ss wire for retention of the anchor teeth. 2. Auxiliary spring in the molar tube: <ul style="list-style-type: none"> ◦ 17x25 TMA without a helical loop or 19x25 ss with a loop. ◦ Mesial arm of the spring should be adjusted to lie passively in the vestibule and upon activation should hook over the archwire in the stabilizing segment ◦ The hook should be positioned so that it is free to slide distally as the molar uprights ◦ Lingual bend in the spring to counteract forces which tend to tip the anchor teeth buccally and the molar lingually. (because the force is applied to the buccal surface)
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	<ul style="list-style-type: none"> - A bonded lingual stabilizing wire from canine-to-canine should be placed to control the incisor position if molars are uprighted on both sides simultaneously. - Tx time: <ul style="list-style-type: none"> o 8-10 w. o Failure to eliminate occlusal interferences prolong tx. o If 2 molars are uprighted in the same quadrant: 6 m. - <u>Aufrichtefeder: Tip-back Feder (One-Couple-System)</u>  <ul style="list-style-type: none"> - 016x022 Stahldraht, Schlaufendurchmesser 3mm, Helixanzahl: 2.5 Windungen - 017x025 TMA ohne Helix - effiziente Molarenaufrichtung: Drehmoment: 2000-3000gmm - Variierung des Momentes: Aktivierungswinkel ↑ -> Moment ↑, F vert. ↑ Akt. Winkel konst., Länge ↑ -> F vert. ↓ in der 3. Potenz, Moment ↑. (Das Moment ändert sich prop. Zur Länge, die Kraft ändert sich in der 3. Potenz zur Länge aufgrund der Federrate) <p>Nebeneffekt: Extrusion des Molaren, Intrusion PM Entstehung von ev. Interferenzen (cave bei Erwachsenen-TH)</p> <ul style="list-style-type: none"> - <u>Aufrichtefeder ohne vertikalen Kräfte (Two-Couple-System)</u>  <ol style="list-style-type: none"> 1. Bogen passiv biegen. 2. Gleich starke Aktivierung am mesialen und distalen Ende. <p>→ Gleiche starke, einander entgegengesetzte Momente. → Keine vertikalen Kräfte.</p> <ul style="list-style-type: none"> - Teilbogen aus geradem 017x025 TMA - Passiv im Attachment vom PM und Molaren - 45 Grad Aktivierung nach Gingival in alpha und beta- Position -> Burston VI, keine vertikalen Kräfte
Uprighting a single molar: 2. Mesial root movement	<ul style="list-style-type: none"> - Skeletal anchorage is needed if the extraction space should be closed. - <u>If goal = small amount of mesial movement:</u> <ul style="list-style-type: none"> • T-loop sectional archwire 17x25 ss or 19x25 beta-Ti adapted to fit passively into the brackets on the anchor teeth (after initial alignment) and gabled at the T to exert an uprooting force on the molars. • Insertion on the molar from mesial (normal case) or distal (severely tipped or rotated molars) - <u>If goal = maintain or close the pontic space:</u> <ul style="list-style-type: none"> • The distal end of the archwire should be pulled through the molar tube, opening the T-loop by 1-2 mm and the wire end bent sharply gingival to maintain the opening. - <u>If goal = opening the space:</u> <ul style="list-style-type: none"> • End of the wire is not bend over → tooth can slide distally along it. (the T-loop is also opened) - The T-loop is also indicated if the molar to be uprooted is severely tipped but has no occlusal antagonist → T-loop minimizes the extrusion that accompanies the uprooting.

		<p>(A) T-loop spring in 17×25 steel wire, showing the degree of angulation of the wire before it is inserted into the molar tube that is necessary to upright a single-tipped molar. (B) If a T-loop is activated by pulling the distal end of the wire through the molar tube and bending it, the tooth cannot move distally. This generates a moment that results in molar uprightness by mesial root movement with space closure. (C) A T-loop for uprightness by distal tipping. Note that the tooth can move back by sliding along the wire. (D) Modification of a T-loop that can be used to upright a severely tipped or rotated molar by distal tipping. The wire is inserted into the distal end of the tube on the molar. The additional wire in the loop provides a longer range of action, but the uprightness still is by distal crown tipping.</p>															
NiTi-SE-Stahl-Aufrichtefeder nach Sander / Wichelhaus:	<ul style="list-style-type: none"> - Superelastischer Draht beim Molaren mit Tip- back- Abwinkelung 15° (016x022) - Klemmverbindung zu Stahldraht (017x025) - Kreuzröhrenchen distal Eckzahn - Verblockung der Zähne mit 8er Ligatur, um Mesialisierung der Wurzel zu erreichen, resp. Distalkippung der Krone zu verhindern <table border="1" data-bbox="722 887 1087 1358"> <thead> <tr> <th>Winkelverhältnis</th> <th>Konstruktion Aufrichtefeder</th> <th>Kräfte und Momente</th> </tr> </thead> <tbody> <tr> <td>$\alpha = \beta$</td> <td></td> <td></td> </tr> <tr> <td>$\alpha > \beta$</td> <td></td> <td></td> </tr> <tr> <td>$\alpha < \beta$</td> <td></td> <td></td> </tr> <tr> <td>$\alpha < \beta$ $\alpha = \beta$ + Stufe</td> <td></td> <td></td> </tr> </tbody> </table> <ul style="list-style-type: none"> - 1. $\alpha = \beta$: ohne vertikale Kompensationskräfte - 2. $\alpha > \beta$: Aktivierung bei α ist stärker, dadurch Kompensationskräfte in umgekehrter Richtung (Extrusion bei α, Intrusion beim Molaren) - 3. $\alpha < \beta$: kleineres Moment am Verankerungssystem, Molar wird stärker aufgerichtet als bei 2., erfährt aber eine Extrusion - 4. 3. + Stufe: Verstärkung der vertikalen Stufe führt zur Vergrößerung der vertikalen Kräfte: Intrusion des Molaren, Extrusion der Front, zudem entsteht ein kleineres Aufrichtemoment für den Molaren, sowie ein grösseres Drehmoment für den Verankerbereich (2-3x)(Summe der Kräfte = 0) 		Winkelverhältnis	Konstruktion Aufrichtefeder	Kräfte und Momente	$\alpha = \beta$			$\alpha > \beta$			$\alpha < \beta$			$\alpha < \beta$ $\alpha = \beta$ + Stufe		
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Uprighting a single molar: Final positioning of the molar and premolars	<ul style="list-style-type: none"> - Stiff base wire 1 mm extended distal the molar tube with a compressed coil spring 1-2 mm longer than the space (150 gm). Reactivation is possible by placing a split sparer over the wire. → The spaces between the premolars are closed & the pontic space opened. 																

Uprighting 2 molars in the same quadrant	<ul style="list-style-type: none"> - Attempt only small amounts of space closure as the resistance is considerable. - The goal should be a slight distal tipping of both crowns for a premolar-size pontic or an implant. - Uprighting 2nd & 3rd molars bilaterally is a bad idea, unless skeletal anchorage is used to avoid considerable movement of the anchor teeth. - Lower arch: A bonded canine-to-canine retainer is needed to control the position of the anterior teeth. - <u>If 2nd & 3rd molar are planned to be uprighted:</u> <ul style="list-style-type: none"> • Single rectangular tube on the 3rd molar, bracket on the 2nd molar. (increased flexibility of the wire mesial and distal of the 2nd molar needed, as it is often more severely tipped) • High flexible wire: 17x25 A-NiT • If excessive tooth mobility is present, reduce occlusal interferences.
Retention of uprighted molars	<ul style="list-style-type: none"> - Avoid a long delay until making the final prosthesis. - A fixed bridge can and should be placed within 6 weeks after uprightness is completed. - If a longer retention is needed (i.e. for a bone graft prior to implant placement): <ul style="list-style-type: none"> • Intracoronal wire splint (= A-splint) made from 19x25 or heavier ss bonded into shallow preparations in the proximal enamel of abutment teeth.
Adjunctive treatment procedures: Crossbite correction	
Elastics	<ul style="list-style-type: none"> - Tipping the teeth into the correct position also extrudes them at the same time. → Cave: The occlusal relationships throughout the mouth could be damaged. - Stabilize several teeth in the lower arch by a heavy archwire segment to obtain more movement of a mx tooth than its antagonist (or the opposite). - Elastics are rarely indicated for anterior teeth. - <u>Mesial tipped lower molars in a buccal crossbite:</u> An uprightness spring can move it lingually by modification of the design: <ul style="list-style-type: none"> • Omit the inward bending of the spring before activations. • Make the spring from a round wire.
Anterior crossbite due to a displaced tooth 	<ul style="list-style-type: none"> - Tip the tooth in a correct position with a removable appliance or clear aligner. → Cave: Tipping of a tooth also changes the occlusal level = OB. → Relapse must be anticipated if a negative OB is created! - Fixed appliances are necessary for vertical control during the correction. - Use a temporary bite plane to free the occlusion if a deep OB exists. Cave: All occlusal surfaces of the teeth must be in contact with the plate to prevent supereruption during tx. The bite plate can be removed as soon as the patient can bite behind the tooth which was in crossbite.
Retention	<ul style="list-style-type: none"> - Good OB = Key to maintain crossbite correction. - Crown reconstruction can help to provide positive occlusal indexing while eliminating any balancing interferences from the lingual cups of posterior teeth.
Adjunctive treatment procedures: Extrusion = Forced eruption	
Indications	<ul style="list-style-type: none"> - Alternative to crown-lengthening surgery for defects in or adjacent to the cervical third of the root. - Allow placement of a rubber dam for endodontic therapy. - Allow the crown margins to be placed on sound tooth while maintaining an uniform gingival contour with improved esthetics. - Isolated one or two-wall vertical pockets: <ul style="list-style-type: none"> • Surgery is maybe contraindicated in the anterior region for esthetic reasons. • Forced eruption + concomitant crown reductions can improve periodontal conditions with improved esthetics.

Biology	<ul style="list-style-type: none"> - Alveolar bone height is not compromised. - Apparent crown length is maintained. - Attached gingiva follows the cementoenamel junctions, mucogingival border remains mostly on the same level: → Width of the attached gingiva returns to its original level. - Usually some recontouring of the gingiva & often recontouring of the bone necessary to produce an even contour between adjacent teeth and a proper biologic width. - Control of apical infections should be completed before extrusion. → Only temporary root filling, if the access must be improved first.
Procedure principles	<ul style="list-style-type: none"> - <u>Determination how much a tooth must be extruded:</u> - Location of the defect. - Space necessary to place the margin of the restoration so that it is not at the base of the gingival sulcus (typically 1 mm needed). - Allow enough space to respect the biologic width of the gingival attachment. (about 2 mm) - Size of the pulp chamber or the root canal at the level of the margin of the future restoration. - Crown-root ratio should be 1:1 or better at the end of tx. → Splinting to adjacent teeth is necessary if this cannot be achieved. - Rate: 1 mm/w extrusion is possible without damage to the PDL. - Too much force / too rapid movement runs the risk of damaging the tissue and risk for ankylosis. - Control appointment every 1-2w: Any occlusal contact which could impede eruption must be removed. - Ample anchorage is usually available from anchor teeth as extrusion occurs more easily compared to intrusion. - Retention minimum 3 weeks, but not more than 6 weeks after completion of tooth movement necessary to allow reorganization of the PDL. - Periodontal surgery to recontour the alveolar bone / reposition the gingiva can be done a month after completion of extrusion - Complete definitive prosthetic tx without extensive delay.
Orthodontic technique	<ul style="list-style-type: none"> - <u>Extrusion of anterior teeth:</u> The appliance needs to be quite rigid over the anchor teeth and flexible where it attaches to the tooth, which should be extruded. <ul style="list-style-type: none"> o A: Continuous archwire Cave: adjacent teeth tend to tip towards the tooth being extruded, reducing the space available. <i>Note: Horizontal forces from Bantleon effect?</i> o B: Flexible cantilever spring wire (e.g. segmental T-loop) o C: Rigid stabilizing wire and an auxiliary elastomeric module or spring for extrusion  - <u>Severely intruded posterior teeth, option 1:</u> <ol style="list-style-type: none"> 1. Stabilizing wire 19x25 or 21x25 ss bonded direct to the facial surface of the adjacent teeth. 2. Post and core with a temporary crown and pin placed on the tooth to be extruded. 3. Elastomeric module used to extrude the tooth / interarch elastics or a flexible archwire <p>→ Simple appliance with excellent control of the anchor teeth. → Better control can be obtained when orthodontic brackets are used.</p> - <u>Severely intruded posterior teeth with completely destroyed crowns, option 2:</u>

	<ul style="list-style-type: none"> ○ Place an orthodontic band with a bracket on the remaining root surface. → The band also helps for isolation procedures for endodontic tx. ○ Bond adjacent teeth to serve as anchor unit
Adjunctive treatment procedures: Alignment of anterior teeth	
Diastema closure / space redistribution	<ul style="list-style-type: none"> - Do a diagnostic setup for tx planning. - <u>Options 1:</u> Partial fixed appliance with bonded brackets on most if not all the maxillary teeth and a bonded tube 6+6 for additional anchorage. <ul style="list-style-type: none"> • Initial alignment with light wires. • Reposition the teeth with elastomeric modules or coil springs. • Bond a flexible wire on the lingual surface after the diastema closure to prevent space reopening. - <u>Option 2:</u> Sequence of clear aligners. <ul style="list-style-type: none"> • For modest tooth movements: Aligners made by resetting the teeth on a dental cast that can be reshaped by the doctor. • For extensive tooth movements: Invisalign. Cave: Rather comprehensive than adjunctive tx.
Crowded, rotated and displaced incisors	<ul style="list-style-type: none"> - Lack of space is mostly the problem. - Option 1: Arch expansion: Done by clear aligners or a partial fixed appliance (more efficient and cost-effective) if aesthetics are no concern. <ul style="list-style-type: none"> • A segment of A-NiTi wire with stops to make it slightly advanced: = usually best way to bring the teeth into alignment. - <u>Option 2: Stripping:</u> <ul style="list-style-type: none"> • Indicated for mildly crowding situations. • Cave: Effect on OJ, OB, posterior intercuspatation and esthetics. - <u>Option 3 (comprehensive tx): Remove one lower incisor.</u> - Good long-term stability maybe requires fibrotomy. - Retention is necessary until restorative or other tx is completed.

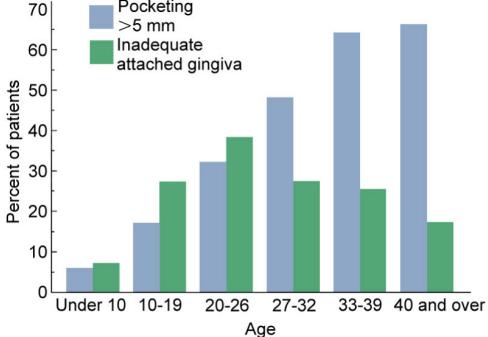
Comprehensive treatment in adults	
Psychologic considerations	<ul style="list-style-type: none"> - Children: Tend not to become emotionally involved in their tx. (Cave: Tx is sometimes in the focus of the adolescent rebellion) - Adults seek tx because they WANT it = internal motivation → More likely to respond well psychologically. - Sometimes a hidden set of motivations exists = external motivation: <ul style="list-style-type: none"> • Effort to improve the personal appearance / deal with social problems. • Discuss patient's perception with the doctor's evaluation. → Unrealistic expectations cannot be fulfilled. - Adult patients have often a more positive self-image than the average people. → Ego strength rather than weakness characterizes them. - Demand for better appearing appliances. → Cave: Always leads to tx compromises (time / possibilities...) - Visibility of an appliance is not a matter of concern esp. in the US as orthodontic tx is socially accepted. - Tx in a private area is maybe preferable for some adults, but learning from interacting with other patients helps to understand and tolerate the tx procedures. - Increased interest in tx, but not automatically more compliant with instructions. Sometimes active decision not to do it. - Less tolerant of discomfort, more likely to complain about pain after adjustments. - More difficulties in speech, eating & tissue adaptions.

Comprehensive treatment in adults: Temporomandibular dysfunction as a reason for orthodontic treatment	
Types of problems	<p>4 Groups:</p> <ol style="list-style-type: none"> 1. Masticatory muscle disorders 2. TMJ disorders 3. Chronic mandibular hypomobility 4. Growth disorders <p>- Muscle spasm and joint pathology can coexist → distinction in many patients is difficult.</p> <p>- Sources:</p> <ul style="list-style-type: none"> • Clenching, grinding (stress response) • Internal joint pathology <p>→ Both lead to muscle spasm & fatigue → TMD symptoms (pain, joint noise, limited opening).</p> <pre> graph LR A[Clenching, grinding stress response] --> B[Muscle spasm and fatigue] C[Internal joint pathology] --> B B --> D[TMD symptoms: pain joint noise limited opening] C -.-> D </pre>
Principles of tx	<ul style="list-style-type: none"> - Orthodontic tx can sometimes help patients with TMD related to excessive clenching or grinding, but it cannot be relied on to correct these problems. - No tx success for patients with internal joint problems or other non-muscular sources of pain. - Patients with myofascial pain / dysfunction may benefit from improved dental occlusion. - Patients with arthritic changes in other joints: TMJ is likely to be involved. - A component of muscle spasm and muscle pain should be suspected in patients with symptoms only in the TMJ, even if the x-ray shows moderate arthritic degeneration. - Disk (soft tissue) is best represented with a MRI. - CT/CBCT is preferred for visualization of bony changes.
Displacement of disk	<ul style="list-style-type: none"> - Can arise from several causes. - <u>Possible sequence of events:</u> <ol style="list-style-type: none"> 1. Trauma to the joint 2. Ligaments which oppose the action of the lateral pterygoid muscle are stretched or torn. Lig. Temporomandibulare = Lig. Laterale. Lig. Sphenomandibulare. 3. Contraction of the m. pterygoideus lateralis moves the disk forward as the mandibular condyles translate forward on wide opening → click. 4. The ligaments do not restore the disk to its proper position when the jaw is closed → click.
Tx of the "click" noise of the disk	<ul style="list-style-type: none"> - Occlusal splint to prevent the patient from closing beyond the point at which displacement occurs. → If the symptoms are controlled, the splint can normally gradually be reduced and later removed. - Increase of vertical facial dimension: <ul style="list-style-type: none"> • Restorative • Elongation of all posterior teeth → Adapt with care! Better ways exist to handle disk displacements than orthodontic tx.
Origin of myofascial pain	<ul style="list-style-type: none"> - Involved factors: Always BOTH must be present <ul style="list-style-type: none"> • Muscles which are overly fatigued and tend to go into spasm • Occlusal discrepancy - Muscle fatigue is always caused by clenching or grinding. It cannot be produced to this extent during normal eating and chewing. - Great variation exists how individuals respond to stress. - <i>Slade, 2016:</i> Impossible to say that occlusal discrepancies of any given degree will lead to TMJ disease symptoms

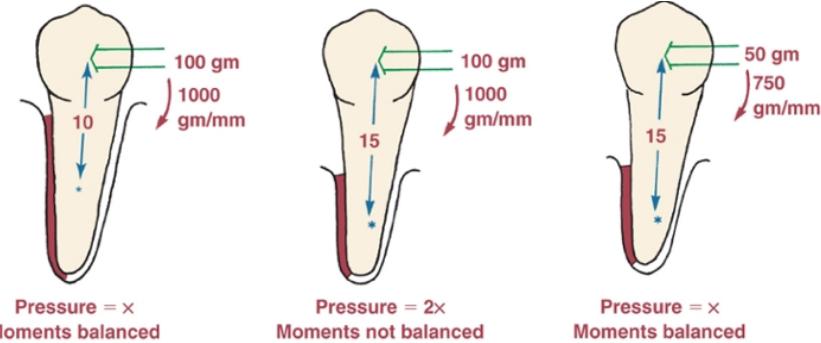
	<ul style="list-style-type: none"> - Some types of occlusal discrepancies predispose patients who clench or grind their teeth to develop TMJ disease symptoms. <p><i>McNamara:</i></p> <ul style="list-style-type: none"> • OJ > 6mm • Verlust mehrerer posteriore Zähne • Anterior offener Biss • Lateraler Zwangsbiss • Ausgeprägte RK/IK-Diskrepanz <ul style="list-style-type: none"> - BUT: TMJ disease is not more prevalent in patients with severe malocclusions than in the general population. (Okeson, 2013) <p>→ Malocclusion is not a primary cause of TMJ disease.</p>
Tx indications	<ul style="list-style-type: none"> - Tx options: <ul style="list-style-type: none"> 1. First: Stress reduction 2. Stress control / adaption 3. Improvement of the occlusion - Drastic alterations of the occlusion / orthognathic surgery may help to treat TMD, but should be performed only as second step. - Changing the occlusal relationship contributes to breaking up the habit that contributes to muscle fatigue / pain. - TMD symptoms mostly disappear with an orthodontic intervention, even before the occlusion is corrected: Teeth become sore during orthodontic tx → grinding sensitive teeth to handle stress, does not produce the same subconscious gratifications as before → parafunction stops, symptoms disappear. - Symptoms are unlikely to be present while movement of a sign. number of teeth is occurring, as long as strongly deflective contacts are avoided. - Prolonged use of cl II/III elastics in adults with TMD are not well tolerated. - TMD often reoccurs with removal of the appliance: → An occlusal splint can help.
Interocclusal splint	<ul style="list-style-type: none"> - Must cover all teeth - Cave: If the splint covers the posterior, but not the anterior teeth: → Elongation of the anterior teeth possible. → No contact of the posterior teeth. → Elongation of the posterior teeth with orthodontic tx, crowns or intrusion of the anterior teeth necessary. → Sign. increase in face height. - Orthodontic tx is difficult after splint removal: → TMD symptoms are likely to develop immediately after splint removal.
Discussion	<ul style="list-style-type: none"> - 30% incidence of clenching in the populations. - Success of TMJ surgery: 50% → Always prefer a conservative approach. - Eigenschaften KG: <ul style="list-style-type: none"> • Faserknorpel = ø primäres Wachstumspotential, wächst nur adaptiv. • Sekundärer Knorpel: Bildet sich auch Knochen, ø auf BG-Vorstufe. • Kollagen Typ 1 = ø regenerierbar. • Wachstumszone intraartikulär. • Rotation + Translation. • Beide Gelenke (re+li) miteinander verbunden. - Extremitätengelenk: <ul style="list-style-type: none"> • Hyaliner Knorpel. • Primärer Knorpel: Zone mit Säulenknorpel, BG → Knorpel. • Kollagen Typ 2. • Wachstumszone extraartikulär. • Rotation. • I.d.R. unabhängig zu Nachgelenken. - Histologie Kondylus. <ol style="list-style-type: none"> 1. Fibröse BG-Zone 2. Proliferative pluripotente Zone 3. Hypertrophe Knorperzellenschicht 4. Enchondrale Ossifikation 5. Subchondraler Knochen <p>Normaler Knorpel = Aufbau, ausgenommen dass die fibröse BG-Zone fehlt.</p>

	<ul style="list-style-type: none"> - Diskus: <ul style="list-style-type: none"> Trennt die Gelenkkammer: cranial Scherrbewegung, kaudal Scharnierbewegung. • Pars posterior: <ul style="list-style-type: none"> ◦ Elastische Fasern. ◦ Dickster Anteil. ◦ Ansatz an die bilaminäre Zone. • Pars anterior: <ul style="list-style-type: none"> ◦ Einstrahlende Fasern des M. pterygoideus lateralis Caput superior. ◦ Anzahl einstrahlende Muskelfasern ↓ → Risiko Diskusverlagerung ↑ • Pars intermedius <ul style="list-style-type: none"> ◦ Zentrisch über dem Condylus. ◦ Fasern strahlen in den Condylus ein. - Bilaminäre Zone: <ul style="list-style-type: none"> • Stratum superior: <ul style="list-style-type: none"> ◦ Elastische Fasern → ziehen den Diskus beim Mundschluss zurück. • Genu vasulosum: <ul style="list-style-type: none"> ◦ Arterio-venöser Shunt, Pufferfunktion. • Stratum inferior: <ul style="list-style-type: none"> ◦ Kollagene Fasern → Stabilisierung & Bewegungslimitation des Diskus. - Ursachen KG Beschwerden: <ul style="list-style-type: none"> • Orthopädische Instabilität • Trauma • Emotionaler Stress • Deep pain input • Muskelhyperaktivität: Bruxismus, Pressen. • Interne KG- Erkrankung: Arthrose, Tumor... - Therapie KG Beschwerden: <ul style="list-style-type: none"> • Selektives Einschleifen • Prothetische Therapie abnehmend / festsitzend • Erhöhung der vertikalen Dimension • KFO: Okklusionsänderung stoppt Habit, das zum Knirschen führt. • Schienentherapie: Prinzip = Mundschluss verhindert hinter dem Punkt wo eine Diskusverlagerung stattfindet. • Stress Reduktion / Kontrolle / Coping Mechanismen • Kombination - Ligamente involviert im KG: <ul style="list-style-type: none"> • Lig. sphenomandibulare. • Lig. temporomandibulare = Lig. laterale. • Lig. stylomandibulare. • Lig. collaterale laterale & mediale: bilden die KG Kapsel & fixieren den Diskus. ø dehnbar, nur elongierbar, spezifische Länge. <p>F: Limitation der Bewegung in Grenzpositionen, ø beteiligt bei der normalen Gelenkfunktion.</p> - Mundschliesser: <ul style="list-style-type: none"> • M. temporalis (3 Anteile) • M. masseter: 2 Anteile = Pars superficialis, Pars profundus. • M. pterygoideus medialis: Muskelschlinge mit M. masseter. - Mundöffner: Voraussetzung = Os hyoid fixiert durch die infrahyoideale Muskulatur. <ul style="list-style-type: none"> • M. mylohyoideus (bildet den Mundboden) • M. digastricus V. anterior. • M. geniohyoideus. • M. pterygoideus lateralis Caput inferior. - Retraktoren: <ul style="list-style-type: none"> • M. digastricus V. posterior. • M. temporalis Pars horizontalis. • M. geniohyoideus. - Protrusion: <ul style="list-style-type: none"> • M. pterygoideus lateralis Caput inferior symmetrisch aktiviert.
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	<ul style="list-style-type: none"> - Laterotrusion: <ul style="list-style-type: none"> • M. pterygoideus lateralis Caput inferior asymmetrisch aktiviert. (Laterotrusion zur Gegenseite) - Orthopädische Prinzipien: <ul style="list-style-type: none"> • Alle synovialen Gelenke werden durch Muskeln zusammen gehalten. • Gelenkflächen werden in Kontakt gehalten. • Der interartikuläre Druck wird durch die Muskeln um das Gelenk bestimmt. • Muskuloskeletal stabile Position = physiologische Neutralstellung. → Condylus & Diskus werden durch die KG-Muskulatur stabilisiert. - Bewegungsausmass KG: <ul style="list-style-type: none"> • Max. Mundöffnung: >42 mm • Laterotrusion >8 mm • Protrusion >7 mm
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Comprehensive treatment in adults: Periodontal considerations																						
Prevalence	<ul style="list-style-type: none"> - Young patients: <ul style="list-style-type: none"> • Periodontal diseases usually do not arise. • Higher tissue resistance: A gingivitis almost never develops into a periodontitis. • Generalized periodontitis needs a prober diagnosis → often blood disease. - <i>Moriarty, 1984:</i> <ul style="list-style-type: none"> • A nearly straight-line relationship between the age and periodontal pocketing up to the late thirties exists. • Peak of prevalence of mucogingival problems in the twenties.  <table border="1"> <caption>Data from Moriarty (1984) showing the percent of patients with pocketing > 5 mm and inadequate attached gingiva by age group.</caption> <thead> <tr> <th>Age Group</th> <th>Pocketing > 5 mm (%)</th> <th>Inadequate attached gingiva (%)</th> </tr> </thead> <tbody> <tr> <td>Under 10</td> <td>5</td> <td>7</td> </tr> <tr> <td>10-19</td> <td>17</td> <td>27</td> </tr> <tr> <td>20-26</td> <td>32</td> <td>38</td> </tr> <tr> <td>27-32</td> <td>48</td> <td>28</td> </tr> <tr> <td>33-39</td> <td>63</td> <td>25</td> </tr> <tr> <td>40 and over</td> <td>65</td> <td>18</td> </tr> </tbody> </table> <ul style="list-style-type: none"> - History of disease = best indicator that a disease may be present. - Orthodontic appliances make oral hygiene more difficult. 	Age Group	Pocketing > 5 mm (%)	Inadequate attached gingiva (%)	Under 10	5	7	10-19	17	27	20-26	32	38	27-32	48	28	33-39	63	25	40 and over	65	18
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Characteristics of periodontal disease	<ul style="list-style-type: none"> - Degenerative process ≠ Ø continues, Ø progressive. - Episodes of acute attacks on some, but usually not all areas of the mouth, followed by quiet periods. - 3 groups of progression of periodontal bone loss: <ul style="list-style-type: none"> • Rapid: 10% • Moderate: 80% • No progression: 10% - <i>Prof. Salvi:</i> <ul style="list-style-type: none"> Risk factors for periodontitis continuation / relapse: <ul style="list-style-type: none"> • Restpockets > 6mm • BOP > 25% • Furcation involvement > 3mm (= grade 2 & 3) Characteristics for periodontal doubtful teeth: <ul style="list-style-type: none"> • Furcation involvement grade 2 & 3 • Angular (=vertical) defects • Horizontal bone loss ≥ 2/3 of the root length - If the disease is under control, there is no contraindication for orthodontic tx. - Space closure in areas with major bone loss sometimes leads to an improvement in bone height if at least one wall of the periodontal pocket is remained. - Bacteria = Main etiologic factor. Genetic disposition in some cases. → The effect is determined by the host response. - <i>Seminar ZMK:</i> <ul style="list-style-type: none"> <u>Resistance of the biofilm:</u> <ul style="list-style-type: none"> • Quorum sensing: Interchange of signals, toxins, metabolites... • Interchange of genes • Production of bacteriocins • Extracellular matrix formation <u>Main pathogenic bacteria:</u> <ul style="list-style-type: none"> • Aggregatibacter actinomycetemcomitans = A.a. • Porphyromonas gingivalis = P. gingivalis • Treponema denticola • Tannerella forsythia 																					

Diagnosis	<ul style="list-style-type: none"> - BOP - Evaluation of subgingival plaque and crevicular fluids for the presence of indicator bacteria / enzymes / chemical mediators. - Examine the level and condition of the attached gingiva: - Width. (not all keratinized gingiva is attached) - Thickness. - <i>Prof. Sculean:</i> <ul style="list-style-type: none"> • Gingivadicke ist wichtiger als Breite um Rezessionen zu vermeiden. • Biotype: Defined by genetics <ul style="list-style-type: none"> ◦ Thin scalloped 12-81% ◦ Thick scalloped ◦ Thick flat <p>→ Transplant of keratinized gingiva into mobile mucosa remains stable.</p> • Phenotype: Defined by local factors. • Positive Korrelation zwischen: <ul style="list-style-type: none"> ◦ Gingiva Dicke. ◦ Keratinisiertes Gewebe. ◦ Knochenmorphologie Typ.
Recessions	<ul style="list-style-type: none"> - Labial movement of incisors can be followed by gingival recessions and loss of attachment in some patients. - Greatest risk if irregular teeth are aligned by expanding the dental arch. - Prof. Salvi: <ul style="list-style-type: none"> • The thickness of the gingiva is more important than the width. • Risk for recession formation: <ul style="list-style-type: none"> ◦ Thin biotype. ◦ Insufficient width of the keratinized gingiva. ◦ Inflammation. ◦ Recession before orthodontic tx. - Present concept <ol style="list-style-type: none"> 1. Stress of the tissue: Toothbrush trauma, plaque-induced inflammations, stretching / thinning of the gingiva created by labial tooth movement. 2. Alveolar bone dehiscence → Leads secondary to recessions. - Once recessions begin, rapid progression is possible esp. if little or no keratinized attached gingiva exists. - Prevention of recessions is better than correction later: → Consider a gingival graft for patients with minimal attached gingiva or thin tissue esp. if arch expansion, surgical mn advancement or genioplasty is planned.
Tx of patients with minimal periodontal involvement	<ul style="list-style-type: none"> - Plaque control. - Examination of the gingiva. - Simple appliances. - SS-Lig. instead of plastic moduls. - SS-bracket instead of ceramic or composite brackets. - Ø difference self-ligating vs. conventional ligating brackets. (Evidence is controversial) - Consider skeletal anchorage (reduced anchorage from the teeth) - Permanent retention. - Best gingival index values: Invisalign > lingual appliances > labial appliances.
Tx of patients with moderate periodontal involvement	<ul style="list-style-type: none"> - Remove all calculus prior to orthodontic tx, incl. flaps if necessary. - Not clear at the moment if a bone graft as part of a corticotomy is indicated to prevent bone dehiscence and gingival recessions when a significant arch expansion is planned. - Defer osseous recontouring or reposition flaps to compensate for gingival recessions until the final occlusal relationship has been established. - Period of observation after the completion of periodontal tx: (Note: Delay of min. 3 months / longer if periodontal surgery was performed) Allow healing of the tissues and make sure that the disease is under control. - Pulpal involved teeth: <ul style="list-style-type: none"> • Endodontic tx prior to orthodontic tx. • Movement of pulpal involved teeth can cause a flare-up of pulpitis and pain. - Caries should be treated with composite resins. Cast restorations should be delayed until the final occlusal relationships have been established with orthodontic tx. - Use fully bonded orthodontic appliance: The margin of bands can make periodontal maintenance more difficult. - Use self-ligating brackets or steel ligatures:

	<p>→ Elastomeric rings have higher levels or microorganisms in gingival plaque.</p> <ul style="list-style-type: none"> - Continue periodontal maintenance therapy at 2-4 m intervals. - Consider adjunctive chemical agents between periodontal controls (incl. CHX if needed) - <i>Ghijssels, 2014:</i> Placement of fixed appliances has an impact on periodontal parameters. Shift to a more anaerobic bacterial flora. Not all parameters are normalized 2 years post-tx, indicating that the changes are only partially reversible.
Tx of patients with severe periodontal involvement	<ul style="list-style-type: none"> - Same principles like for patients with minimal / moderate periodontal involvement. - Schedule periodontal maintenance at more frequent intervals: 4-6 w. - Keep orthodontic forces to an absolute minimum: <ul style="list-style-type: none"> • Reduced area of the PDL after sign. bone loss means higher pressure in the PDL from any force. • Moments created by forces applied to the crown are larger with the center of resistance moving apically. • Less anchorage available.  <p>The diagrams illustrate the relationship between force application, center of resistance, and the resulting pressure and moments on the periodontal ligament (PDL). In the first diagram, a 100 gm force is applied at 10 mm from the center of resistance, creating balanced pressure and moments. In the second diagram, the same 100 gm force is applied at 15 mm from the center of resistance, creating unbalanced pressure and moments. In the third diagram, a 50 gm force is applied at 15 mm from the center of resistance, creating balanced pressure and moments.</p> <ul style="list-style-type: none"> - Hopelessly involved periodontal teeth can be used to support an orthodontic appliance that contributes to save other teeth. - Crown-root length ratio is an important factor for the long-term prognosis (min. 1:1). <ul style="list-style-type: none"> → Shortening of the crown is often indicated instead of intrusion in adults with bone loss if the aesthetics allow it (mn yes, mx rather no to avoid reduction of the tooth display).

Comprehensive treatment in adults: Prosthodontics-implant interactions	
Reasons for need of orthodontic tx	<ul style="list-style-type: none"> Loss of tooth structure from wear / abrasions or trauma Gingival esthetic problems Missing teeth
Problems related to loss of tooth structure	<ul style="list-style-type: none"> The final position of the teeth which are going to be moved must be discussed with the prosthodontist. Orthodontic positioning must provide adequate space for the appropriate addition of the restorative material. <ul style="list-style-type: none"> Total amount of space which should be generated. Mesio-distal and bucco-lingual position within the space. Vertical positioning. Better reconstructions can be done if slightly more space than required for the restorations is available (for finishing & polishing of proximal surfaces). → A slight excess of space can be closed with a retainer. <u>Define in advance what is the reference for leveling:</u> <ul style="list-style-type: none"> Incisal edges and marginal ridges. Gingival margins and contours. Bone levels. <u>For small amounts of lost tooth structure:</u> <ul style="list-style-type: none"> Smooth the fractured area and elongate the damaged tooth so that the incisal edges line up. Cave: Uneven gingival margins. Maximum 1-2 mm elongation unless the patient never exposes gingiva.
Gingival esthetic problems	<ul style="list-style-type: none"> 2 categories: <ol style="list-style-type: none"> Excessive and/or uneven display of gingiva. Gingival recessions after bone loss. Maintaining an even gingival margin in the mx incisor area is esp. important for patients with a high smile line. → Important for tx choice if one lateral incisor is missing. Extruding worn or fractured teeth can create an unaesthetic gummy smile. Mesialisation of a canine in case of unilateral agenesis can lead to uneven gingival margins. IPR is indicated for black triangles to move the contact point more gingival and minimize the open space between teeth.
Missing teeth: Space closure vs. prosthetic replacement	<ul style="list-style-type: none"> <u>Old extraction sites:</u> <ul style="list-style-type: none"> Space closure is difficult: <ul style="list-style-type: none"> Decrease in vertical bone height due to resorption. Narrowing of the alveolar process in the bucco-lingual dimension due to remodeling. → Reshaping of the cortical bone that comprises the buccal and lingual plates of the alveolar process is necessary. Cortical bone responds normally to orthodontic force, but the response is sign. lower. <u>Moving lower molars forward into old premolar extraction spaces:</u> <ul style="list-style-type: none"> Temporary implants in the ramus can be used for anchorage to prevent retracting the incisors. Cortical bone remodeling is usually required. Space closure is likely to be slow. Often it is better judgement to open a partially closed old extraction site and replace the missing tooth.
Tooth loss due to periodontal disease	<ul style="list-style-type: none"> If one bony wall remains, space closure can result in an improvement of the periodontal situation. → In most other cases (= no bony wall remains), a tooth should be moved away from such areas and prosthetic restorations are preferred. Normal bone formation cannot be expected when a tooth is moved into a defect. Exception: Aggressive juvenile periodontitis in adolescents. <u>Aggressive juvenile periodontitis in adolescents.</u> <ul style="list-style-type: none"> Once the disease is under control (needs antibiotics), the causative agent (<i>Actinobacillus actinomycetemcomitans</i>) seems to disappear. Orthodontic space closure of a missing incisor is rarely feasible.

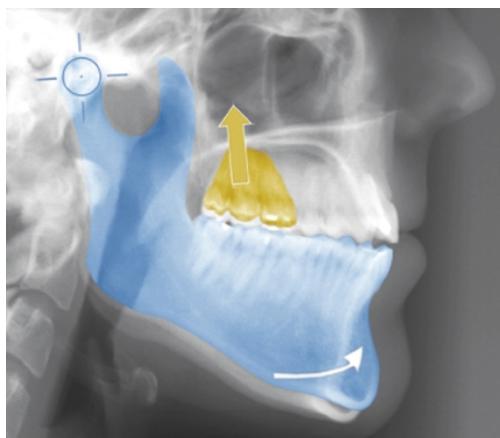
	<ul style="list-style-type: none"> • 2nd molars can be moved into the extraction site of the first molar and bring their investing bone with them → large bony defects disappear. • Factors to predict success: <ul style="list-style-type: none"> ◦ Young patients. ◦ The original attack was almost entirely on the 1st molars. ◦ Change in the bacterial flora.
Comprehensive orthodontics in patients planned for implant therapy	<ul style="list-style-type: none"> - Go ahead with grafts in further implant areas, while the orthodontic tx is carried out. → The patient is ready for implants as soon as the orthodontic appliance is removed. - Implant surgery can maybe carried out before the whole orthodontic tx is finished. → An osseointegration period during orthodontic tx is advantageous. - Fixed orthodontic retainer = Best choice to maintain the space for a later implant. - <u>Damaged and ankylosed maxillary incisors or canines:</u> <ul style="list-style-type: none"> • Can interfere with orthodontic tx to align the other teeth. • Alveolar atrophy occurs, if the tooth is extracted before the vertical growth is completed. • Remove the crown of the offending tooth, but remain the endodontically treated root (or do a (Ca(OH)₂ filling) to “bank” the alveolar bone. → Better chance for successful implant placement without a bone graft. • Pontic tied to an archwire or resin-bonded bridge as a temporary provisory. • Too early placed implants are equivalent to an ankylosed tooth: → Intrusion occurs as the vertical development continues and the other teeth erupt (same problem later) as slow vertical growth continues into middle age.

Comprehensive treatment in adults: Complex treatment procedures	
Lingual orthodontics	<ul style="list-style-type: none"> - Characteristics of lingual appliances: <ul style="list-style-type: none"> • Custom-formed pad for each tooth to provide more secure bonding of the appliance. • Low-profile brackets printed from a new proprietary alloy with bracket slots that are much more precise than those of edgewise brackets. • Wire bending robots. - Shorter span of the archwire between the attachments lingual than buccal. → Stiffness of the material ↑ - All wires including A-NiTi preshaped, as lingual surfaces of the teeth do not line up as well as the facial facets. - Grauer, 2011: Incognito: Precise reproduction of the tx goal of tooth positions within <1 mm or 5° of inclination. Except 2nd molars which are less accurately.
Clear aligners	<ul style="list-style-type: none"> - Possible to treat complex malocclusion nowadays, given that: <ul style="list-style-type: none"> • Bonded attachments are used. • The amount of change between the aligners is reduced. • Some phases of complex tx are provided with fixed appliances. • New records and a new set of revision aligners is often needed during the tx process. • If the amount of tooth movement and tx steps increases, it is better to set an intermediate goal and from there complete the tx. - <u>Overcorrection aligners:</u> <ul style="list-style-type: none"> • Produced by virtual shrinkage of the teeth. → Virtual creation of spaces, which are closed. • Don't use them if no spaces are present after the ordinary aligners.
Applications of skeletal anchorage	<ul style="list-style-type: none"> - Indications: <ul style="list-style-type: none"> • Positioning individual teeth when no other satisfactory anchorage is available. (loss of teeth) • Retraction of protruding incisors. • Distal or mesial movement of molars (or the entire dental arch). • Intrusion of posterior teeth to close an anterior open bite or intrusion of anterior teeth to open a deep bite.
1. Retraction of protruding incisors	<ul style="list-style-type: none"> - Maxilla: <ul style="list-style-type: none"> • Stabilization away from the midline is better than an implant in the center of the palate. • <u>Retraction of single / multiple teeth:</u> Palatal bone screws. • <u>Retraction of the whole arch:</u> Miniplates below the zygomatic arch or palatal bone screws. - Mandible: <ul style="list-style-type: none"> • Alveolar bone screws in the buccal shelf below the molars are recommended for retraction of anterior teeth or the entire mn arch. • Narrow basal bone in the anterior part usually contraindicates torque application during incisor retraction, because of risk for root resorptions. • In Asian adults with significant retraction of incisors, bony spicules sometimes appear between the roots of the teeth. They are created by differential remodeling of alveolar bone as the teeth are moved posteriorly. The bone immediately adjacent to the tooth remodels the same distance as the tooth moves. In affected patients, bone between and over the teeth remodels less and this creates the irregular bony protrusion. The genesis and why Asian people and from this population only a minority is concerned, remains unclear.



2. Retraction and intrusion of protruding incisors	<ul style="list-style-type: none"> - Possible with segmented arch mechanics. - Skeletal anchorage is recommended: With screws between the molar roots or miniplates the required upward and backward force can be achieved. - More difficult than simple retraction of the incisors. - Use A-NiTi springs: = Constant force levels.
3. Distal movement of molars or the entire dental arch	<ul style="list-style-type: none"> - Maxilla: <ul style="list-style-type: none"> • Miniplates / screws in the palate or infrzygomatic process are better than interradicular screws for a predictable outcome. → Roots can be moved without interference from the screws. • The entire arch can be moved 2-4 mm in distal direction (more with extractions). • Extractions of 2nd molars or premolars are maybe necessary. - Mandible: <ul style="list-style-type: none"> • Long bone screws in the mandibular buccal shelf (preferred) or alternatively in the ramus. • Indications for distalization: <ul style="list-style-type: none"> ○ Class III malocclusion with a component of mandibular dental protraction. ○ Incisor protraction created during tx of severe crowding.
4. Molar protraction	<ul style="list-style-type: none"> - Maxilla: Direct anchorage, using a power arm from the molar so that the force direction is near the center of resistance. - Mandible: Short vestibule → Indirect anchorage using the screw wired to an anchor tooth is preferred.
5. Incisor intrusion	<ul style="list-style-type: none"> - Use segmented rather than continuous archwires. - Deepening of periodontal pockets might be produced by tx. Intrusion does not lead to reattachment of periodontal tissues. → Formation of a tight epithelial cuff, so that the position of the gingiva in relation to the crown improves clinically, while periodontal probing depths do not increase. - Bone levels tend to follow the amount of intrusion. - No great affection of root resorption and alveolar bone height. - Alternative approach to intrusion: <ul style="list-style-type: none"> • Remove part of the crown from elongated incisors if the periodontal prognosis (root-crown ratio) is improved and orthodontics facilitated. • Rather used in the mandible than the maxilla (incisor display). - Seminar ZMK: Intrusion of periodontal involved teeth: <ul style="list-style-type: none"> • Ø reattachment of the PDL. • Ø additional attachment win. • Formation of a long junctional epithelium (langes Saumepithel). • The bone follows the intrusion. → Better position of the gingiva to the crown, probing depths do not increase.
6. Intrusion of maxillary posterior teeth to close an anterior open bite	<ul style="list-style-type: none"> - Anchorage: <ul style="list-style-type: none"> • Miniplates • Long bone screws extending into the base of the zygomatic arch. <ul style="list-style-type: none"> ○ Between 1st / 2nd molar if distalization of the dental arch will maybe necessary. ○ Between the 1st molar and 2nd premolar if mesialization of the dental arch will maybe necessary. • Palatal screws: no studies, but should also be effective. - Control facially tipping force during intrusion → A bonded plate covering the occlusal surface of the teeth and fabricated with some distance to the palate can be used.



	
	<ul style="list-style-type: none"> - The mandible rotates upward-forward during intrusion of the mx posterior teeth: <ul style="list-style-type: none"> • By adjusting the point of attachment of the spring to the plate, a cl.II or cl.III component can be added to the force. • May use cl.II or III elastics for compensation. • Eruption of the lower molars must be controlled, if a reduction of the anterior face height is the goal. Avoid relapse of the anterior open bite. 
7. Intrusion of mandibular posterior teeth	<ul style="list-style-type: none"> - Maximum force = ≤ 200 mg to a posterior segment of 3 teeth. - Intrusion = Slower than other tooth movements. Maximum 0.5 mm / m. - 0.5 mm posterior intrusion = 1 mm closure of anterior open bite. - Maximum intrusion: ~ 4 mm. 15-20% lost in short term. - Eruption of the incisors can compensate for relapse of the mx molar intrusion, unexpected late downward growth of the mx or elongation of mn molars. - No studies about long term stability are available at the moment. <p>- Scheffler, 2014: <u>Intrusion of mx posterior teeth with skeletal anchorage</u></p> <ul style="list-style-type: none"> • Mx molar intrusion can give satisfactory correction of moderately severe open bites: up to 6 mm in the long term from intrusion, more with extrusion of incisors. • Lower molar eruption must be controlled to gain a skeletal change with mx molar intrusion. • Clinical experience suggests that intrusion of both mx and mn posterior teeth can allow closure of more severe open bites. • Eruption of mx and/or mn incisors partially compensates for re-rotation of the mn, so bite opening after open bite correction rarely occurs. • Le Fort 1 surgery to superiorly reposition the mx is more likely to produce a significant shortening of anterior face height.

	<ul style="list-style-type: none"> - Spurts attached to the lingual arch to create tongue repositioning away from the open bite.    
Finishing and retention	<ul style="list-style-type: none"> - Positioners: <ul style="list-style-type: none"> • Rarely indicated for adult patients. • Never use in patients with severe periodontal bone loss. - <u>Mobile teeth with severe bone loss:</u> Splinting. - <u>Molar intrusion:</u> Use retainers with posterior bite blocks.

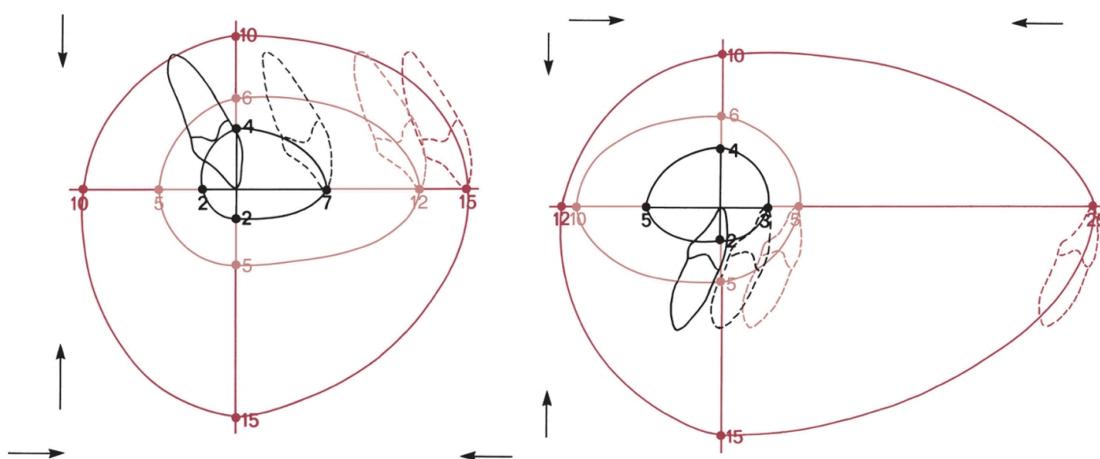
Proffit Chapter 20:

Combined Surgical and Orthodontic Treatment

Indications for surgery	<ul style="list-style-type: none"> - Orthodontic problems that are so severe that neither growth modification nor camouflage can help. - Surgery is not a substitute for orthodontics.
Development of surgery	<ul style="list-style-type: none"> - Early 20th century: Begin of body osteotomies for prognathism. - 1957: Sagittal split ramus osteotomy with IO approach: <ul style="list-style-type: none"> ○ = Begin of the modern surgery. ○ Possibility to lengthen or shorten the mandible. - 1960: Improvement of mx surgery → Le Fort 1. - 1980s: Movements of both jaws, the chin and the dentoalveolar segments possible. - 1990: Rigid internal fixation. - 21th century: Facial distraction osteogenesis.

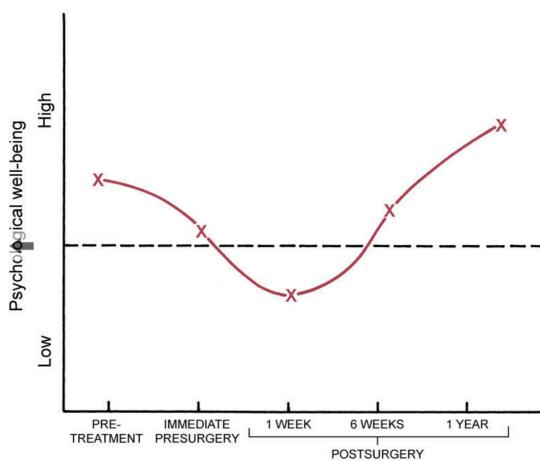
The borderline patient: Camouflage vs. surgery

Influencing factors	<ul style="list-style-type: none"> - Required tooth movement. - Patients age → growth modification possible? - Soft tissue limitations. - Facial appearance is more important than anchorage. - Soft tissue limitations often are a major factor in the decision for surgical or orthodontic tx.
Envelope of discrepancy	<ul style="list-style-type: none"> - Outlines the limits of hard tissue change towards ideal occlusion: <ol style="list-style-type: none"> 1. Orthodontic tooth movement alone 2. Orthodontic tooth movement + growth modification 3. Orthognathic surgery - Potential for tooth movement: <ul style="list-style-type: none"> • Forward > backward • Extrusion > intrusion • Growth modification always includes both jaws → Same envelope.



Orthognathic surgery versus temporary skeletal anchorage	<ul style="list-style-type: none"> - The limits of orthodontic tx are much more a matter of facial appearance than anchorage. - Intrusion of posterior mx teeth is a good alternative to moving the mx up with a Le Fort 1 osteotomy (Scheffler, 2014). Anterior open bite > -6 mm → surgery or intrusion of mx and mn posterior teeth. - Protraction of the maxilla with cl.III elastics to skeletal anchorage is a good substitute for surgery if the mx deficit is not too severe. (De Clerck 2010 & 2012)
Esthetic and psychosocial considerations	<ul style="list-style-type: none"> • If esthetic is a major goal, changes of the nose or the soft tissues (plastic surgery) are may be necessary in addition to the jaw surgery. • <u>Older people:</u> Difficulty to adapt to significant changes in facial appearance. Minimize changes if possible. • <u>Younger people:</u> Wish to change in appearance with orthognathic surgery.

- How well the results match with the tx simulation is an important factor to the patient's reaction after surgery.
- Consider psychological support and counseling.



A generalized representation of the typical psychological response to orthognathic surgery, based on the work of Kiyak (1992).

1. *Prior to treatment, patients who seek orthognathic surgery tend to be above the mean on most psychosocial parameters.*
 2. *Immediately before surgery, they are not quite so positive, as anxiety and other concerns increase.*
 3. *In the days immediately after surgery, a period of negativism typically occurs (e.g., depression, dissatisfaction). This is related in part to steroid use at surgery and withdrawal afterward but is not totally explained by this. (steroid withdrawal, even if used on short term, causes mood swings and a drop in most indicators of psychological well-being)*
 4. *By 6 weeks postsurgery, the patients usually are on the positive side of normal again and at 1 year, typically rate quite high for satisfaction with treatment and general well-being.*
- **Body dysmorphic disorder:**
 - Obsessive preoccupation about one's own appearance.
 - 2.4% of the general population.
 - 10-13% of orthognathic patients.
 - Typical signs: Excessive exercising and dieting, multiple surgeries.
 - Unrealistic expectations, satisfaction impossible, chronic depression.
 - Self-infliction (dt. selbstverstümmelnde) plastic surgery attempts.

Computer simulation of alternative tx outcomes

- Computer simulations are helpful for patients to decide between camouflage or surgery.
- Prediction changes for the profiles are reliable, but not for the frontal view.
- Philips, 2003:
Patients who saw the prediction images before the operation are more likely to be satisfied with their results.
→ Showing predictions to patients does not lead to unrealistic expectations and disappointments with the actual result in general.

Extraction of teeth and then camouflage versus surgery decision

- The decision must be made before orthodontic tx starts, because the tx is often completely different.
- Cl.III problems are less amenable to camouflage than cl.II.
(because retracting the lower incisors makes the chin more prominent)

Camouflage

- Extraction spaces are used to produce dental compensation for jaw discrepancies.

ORTHODONTIC CAMOUFLAGE OF SKELETAL MALOCCLUSION

Acceptable Results Likely

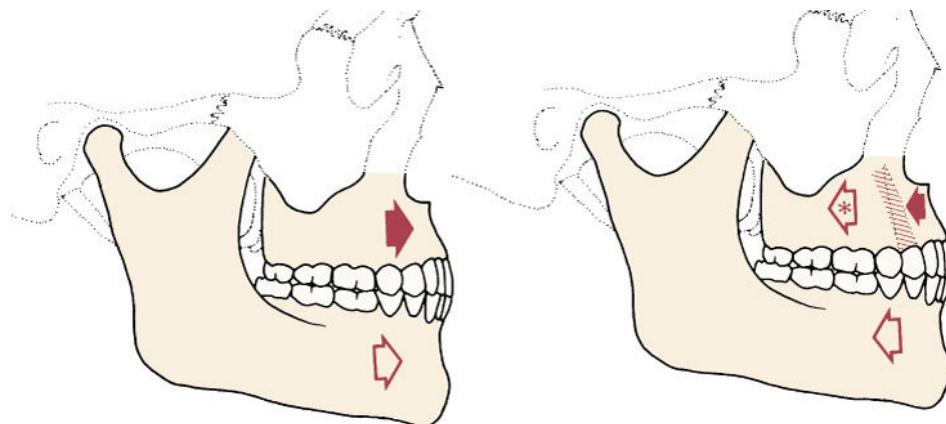
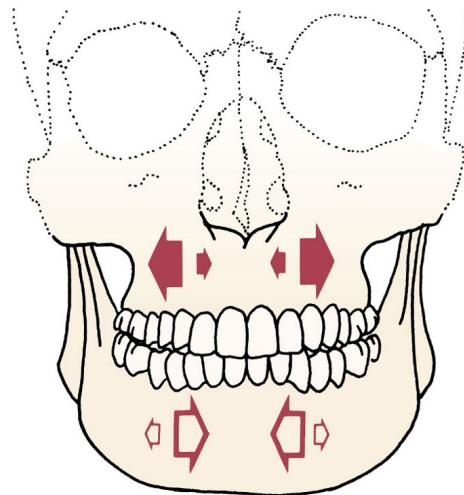
- Average or short facial pattern
- Mild anteroposterior jaw discrepancy
- Crowding <4-6 mm
- Normal soft tissue features (nose, lips, chin)
- No transverse skeletal problem

Poor Results Likely

- Long vertical facial pattern
- Moderate or severe anteroposterior jaw discrepancy
- Crowding >4-6 mm
- Exaggerated features
- Transverse skeletal component of problem

Contemporary surgical techniques

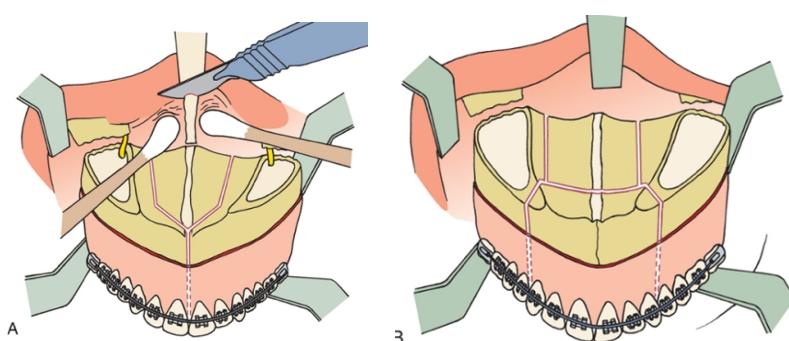
The surgical movements that are possible in the transverse dimension are shown on this posterior-anterior illustration of the skull. The solid arrows indicate that the maxilla can be expanded laterally or constricted with reasonable stability. The smaller size of the arrows pointing to the midline represents the fact that the amount of constriction possible is somewhat less than the range of expansion. The only transverse movement easily achieved in the mandible is constriction, although limited expansion now is possible with distraction osteogenesis.



The maxilla and mandible can be moved anteriorly and posteriorly as indicated by the red arrows in these line drawings. Anterior movements of the mandible greater than approximately 10 mm create considerable tension in the investing soft tissues and tend to be unstable. Anterior movement of the maxilla is similarly limited to 6 to 8 mm in most circumstances - the possibility of relapse or speech alteration from nasopharyngeal incompetence increases with larger movements. Posterior movement of the entire maxilla, though possible, is difficult and usually unnecessary. Instead, posterior movement of protruding incisors up to the width of a premolar is accomplished by removal of a premolar tooth on each side, followed by segmentation of the maxilla. The major limitation of posterior movement of the mandible is its effect on the appearance of the throat. When the mandible is moved back, the tongue moves down as the airway is maintained, and a "turkey gobbler" prominence appears below the chin.

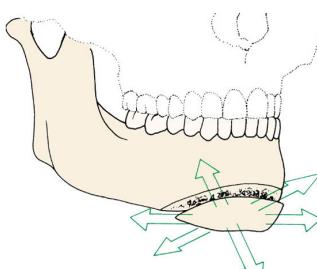
Mandibular Surgery Early 20 th century: Body ostectomies for prognathism 1957: Sagittal split ramus osteotomy with IO approach 1990: Rigid internal fixation	<ul style="list-style-type: none"> - <u>Possible corrections:</u> <ul style="list-style-type: none"> • Back → Cave: Tongue moves down = bad appearance eo. • Forward (~10 mm) → Cave: Tension of the soft tissues = unstable. • Rotation. • Moved down anteriorly to increase the mandibular plane angle and the anterior face height. • Narrowing anteriorly (rarely used, requires removal of an incisor). • Rotation of the tooth-bearing segment down anteriorly. - <u>Possible corrections with reservation:</u> <ul style="list-style-type: none"> • Up rotation to decrease the mandibular plane angle and decrease anterior face height. → Only stable if the maxilla is moved up posteriorly at the same time so that the rotation does not lengthen the ramus and stretch the elevator muscle. • Widening only with distraction (limitation given by the soft tissue). • Surgery involving the condyles / major advancements: <ul style="list-style-type: none"> - EO approach - Requires bone grafts - Distraction osteogenesis
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	<ul style="list-style-type: none"> - Sagittal split osteotomy is used nowadays for almost all mn surgeries, because of several advantages to the ramus osteotomy: <ul style="list-style-type: none"> • Compatible with RIF: → Immobilization of the jaws during healing is not required. • Excellent bone-to-bone contact after the osteotomy minimizes healing problems and provides good postsurgical stability. • Forward & backward movement of the mn is possible. • The tooth-bearing segment can be rotated. - Lower border osteotomy: <ul style="list-style-type: none"> • Adjunctive to ramus osteotomy, esp. when the mn is advanced. • Chin can be moved transversely, forward, backward, up and down. - An asymmetric mn cannot become surgically corrected, if the canines are positioned asymmetric the symphysis.
Maxillary surgery 1960: Le Fort 1	<ul style="list-style-type: none"> - <u>Possible corrections:</u> <ul style="list-style-type: none"> • Up (excellent stability). • Forward (excellent stability): ~6-8 mm, otherwise risk for velopharyngeal incompetence. • Segmental osteotomy for protruding anterior teeth. • Narrowed. - <u>Possible corrections with reservations:</u> <ul style="list-style-type: none"> • Down (instable). • Back (difficult, because of structures behind). • Widening (instable): Stretching the palatal mucosa results in an elastic relapse. - <u>Constriction:</u> Bone removal at the parasagittal osteotomy sites. - <u>Segmental osteotomies:</u> <ul style="list-style-type: none"> • Allow isolated expansion or narrowing of the posterior segments. • Dental relapse is similar to the relapse with SARPE. - <u>Orthopedic palatal expansion in adolescents:</u> <ul style="list-style-type: none"> • Parasagittal osteotomies (A) in the lateral floor of the nose or medial floor of the sinuses that are connected by a transverse cut anteriorly. • 2-piece osteotomy (A): Midline extension running forward between the roots 1+1. → This is can or cannot be included in a 3-piece osteotomy (B). • <u>Expansion:</u> Harvested bone from the downfracture or bank bone is used to fill the void created by the lateral movement of the segments. • <u>Constriction:</u> Bone is removed at the parasagittal osteotomy sites.



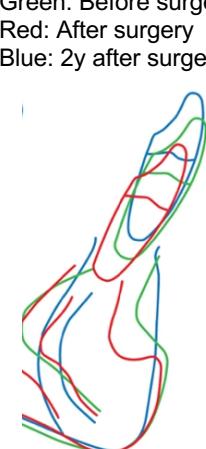
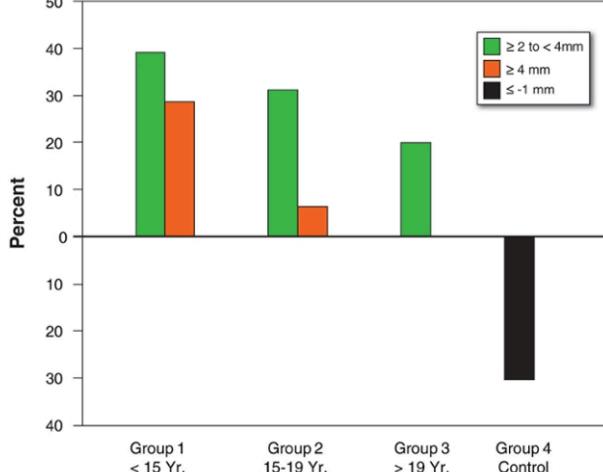
A: Maxilla is showed in a downfractured position during Le Fort 1 osteotomy with the lateral para-midline and anterior midline interdental osteotomies to widen the maxilla in 2 pieces and resection of cartilage of the nasal septum so that the maxilla can be moved up.

B: Location of lateral para-midline and anterior interdental osteotomies for a 3-piece maxilla. This allows widening posteriorly and differential vertical movement of the anterior and posterior segments.

	<ul style="list-style-type: none"> - <u>SARPE: Orthopedic palatal expansion in adults:</u> <ul style="list-style-type: none"> • Expansion for adults is different due to the increasing resistance from the interdigitated midpalatal and lateral maxillary sutures. • <u>Original approach:</u> Cuts in the lateral buttress (dt. Pfeiler) of the maxilla to decrease resistance, so that the midpalatal suture can be forced open. → Cave: Chance of inadvertent fractures in other areas. • <u>Modern approach:</u> Same cuts like for a Le Fort 1 omitting only the final step of downfracture. • The mx can then be expanded only against soft tissues resistance. • Cave: <ul style="list-style-type: none"> ○ No guarantee of symmetric expansion. ○ <i>Chamberland, 2011:</i> Relapse of the dental expansion accompanies SARPE and its long-term stability is similar to relapse with a segmental osteotomy. → Additional costs and morbidity of SARPE as a first stage of surgical tx in a patient who would require another operation to reposition the mx is hard to justify.
Chin surgery	<p>1980: Movements of both jaws, the chin and dentoalveolar segments</p>  <p>The chin can be sectioned anterior to the mental foramen and repositioned in all three planes of space. The lingual surface remains attached to muscles in the floor of the mouth, which provides the blood supply. Moving the chin anteriorly, upward, or laterally usually produces highly favorable esthetic results. Moving it back or down may produce a "boxy" appearance.</p> <ul style="list-style-type: none"> - <u>Indication for preliminary SARPE:</u> A maxillary constriction so severe that a segmental expansion of the maxilla in a Le Fort 1 procedure may compromise the blood supply of the segments. - <u>Lower border procedures for chin movement with good esthetic results:</u> <ul style="list-style-type: none"> • Forward • Up • Transverse - <u>Lower border procedures for chin movement with risk for poor esthetic results:</u> <ul style="list-style-type: none"> • Back • Down

<p>Dentoalveolar surgery</p> <p>1980: Movements of both jaws, the chin and dentoalveolar segments</p>	<ul style="list-style-type: none"> - <u>Segmentosteotomy</u> <ul style="list-style-type: none"> • = Reposition of segments from the dentoalveolar process in all 3 planes of space. • Maximum distances: Few mm (not more than orthodontic movement). • Ideal size: 3 teeth or larger. 2-teeth segments are acceptable, but less predictable. • Blood supply = Collateral circulation via facial and lingual mucosa. → Mucosa must be preserved to maintain tooth vitality and bone integrity. • Segment size ↓ or extent of the movement ↑ → Chance for interrupting the usual blood supply and the collateral supply ↑. - <u>Tooth vitality:</u> (an osteotomy below the root apices cuts the nerves to the pulp of the teeth in that segment) <ul style="list-style-type: none"> ○ Vital, but denervated pulp after surgery = avital. → Pulp vitality can be demonstrated by the maintenance of either normal pulp temperature (temperature probe) or blood flow (Doppler flow meter) ○ Re-innervation often occurs after a few months. ○ Pulp vitality is likely to be maintained by blood flow through auxiliary foramina even when the apex is inadvertently cut off. - <u>Recovery from inadvertent tooth movement:</u> <ul style="list-style-type: none"> • New bone formation can be stimulated with local bone-stimulating hormone therapy and bone grafts: → Fenestrations caused by displaced roots can be corrected.
<p>Distraction osteogenesis</p> <p>21th century: Facial distraction osteogenesis</p>	<ul style="list-style-type: none"> - = Manipulation of healing bone. Stretching of an osteotomized area before calcification occurs in order to generate the formation of additional bone and investing soft tissues. - Osteogenesis (formation of new bone) and histogenesis (formation of new soft tissue) occurs. - Creating new bone with distraction is in general more effective than placing a bone graft, but distraction cannot replace bone grafts in all circumstances. - Pro: <ul style="list-style-type: none"> • Larger distances of movements possible. • Deficient jaws can be increased in size at an earlier age. - Contra: <ul style="list-style-type: none"> • Precise movements are not possible: → Often orthognathic surgery is needed later. • 2 operations are necessary for insertion and removal of the distractor. - Indications: <ul style="list-style-type: none"> • Moderately severe hemifacial microsomia with a rudimentary ramus on the affected side. • Facial syndromes with severe maxillary deficiency. → Sagittal split osteotomy / Le Fort 1 better indicated for less severe deficiencies. • Widening of the mandibular symphysis with formation of a new periosteum over the distracted area: <ul style="list-style-type: none"> ○ Correction with orthognathic surgery is not possible, because there is not enough tissue to cover a bone graft area. ○ No evidence to date that expansion with distraction is more stable than conventional expansion. Cave: Lip and cheek pressure at the corner of the mouth to the canines remains.

Adjunctive facial procedures:

Chin augmentation or reduction	<p>- Lower border osteotomy</p> <ul style="list-style-type: none"> Preferred tx option. Good predictability and stability. The lingual surface remains attached to the muscles in the floor of the mouth which provide the blood supply. Tightens the suprathyroid musculature: → Desirable changes in chin-neck contour. Allow normal lip function in long-face patients with a simultaneously severe anteroposterior problem → = functional genioplasty. Consider gingival grafting before genioplasty if the attached gingiva is inadequate. (lips closed at rest, lips brought into contact without muscle strain) Bone remodeling thickens the alveolar process below the teeth: The notch above the repositioned chin fills in with new bone that extends up to the alveolar crest, creating new bone in an area where it is needed for future gingival stability. Functional genioplasty and augmentation by sliding the chin forward are more successful if done before age 15. → Eruption of lower incisors after genioplasty ↑ = better formation of new bone above the displaced chin. The eruption of the mn canines sets the limit for the earliest timepoint for a genioplasty, because they are in the way of the osteotomy until they moved into the oral cavity. 																				
Alloplastic implant	 <p>Symphysis Thickness Change</p>  <table border="1"> <thead> <tr> <th>Group</th> <th>≥ 2 to < 4 mm</th> <th>≥ 4 mm</th> <th>≤ -1 mm</th> </tr> </thead> <tbody> <tr> <td>Group 1 < 15 Yr.</td> <td>~40%</td> <td>~28%</td> <td>0%</td> </tr> <tr> <td>Group 2 15-19 Yr.</td> <td>~32%</td> <td>~6%</td> <td>0%</td> </tr> <tr> <td>Group 3 > 19 Yr.</td> <td>~20%</td> <td>0%</td> <td>0%</td> </tr> <tr> <td>Group 4 Control</td> <td>0%</td> <td>0%</td> <td>~30%</td> </tr> </tbody> </table> <ul style="list-style-type: none"> Bone remodeling occurs above and behind the repositioned chin, but the bony chin does not remodel and is remarkably stable over time. Chin advancement > 5 mm in older patients can produce notching with the lateral border of the mandible. <p>Solutions:</p> <ul style="list-style-type: none"> Splitting the chin so that the posterior margins can be moved medially to eliminate the notch. Bone graft or alloplastic augmentation materials over the lower border to fill in the posterior notch. Chin reduction is rarely a good camouflage to class III problems: Chin slides only backwards: → The soft tissue chin looks like an underinflated ball because of loss of volume. Vertical reduction of the chin in patients with excessive chin height can greatly increase the facial appearance. <p>- Placement of an alloplastic implant</p> <ul style="list-style-type: none"> Pro: <ul style="list-style-type: none"> Possibility of removal if the patient is unhappy. Less risk of decreased sensation of the lower lip (trauma to the nerve that emerges from the F. mentale to innervate the lip). 	Group	≥ 2 to < 4 mm	≥ 4 mm	≤ -1 mm	Group 1 < 15 Yr.	~40%	~28%	0%	Group 2 15-19 Yr.	~32%	~6%	0%	Group 3 > 19 Yr.	~20%	0%	0%	Group 4 Control	0%	0%	~30%
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	<ul style="list-style-type: none"> • Contra: <ul style="list-style-type: none"> ○ Augmentation only ○ Erosion of the implant into the surface of the bone or migration into the neck is possible. ○ Newer implant materials placed into a soft tissue pocket rather than directly against the bone provide much better stability and have almost totally replaced silicone. → Removal is however difficult and can result in undesired soft tissue changes.
Rhinoplasty	<ul style="list-style-type: none"> - Focus of rhinoplasty: <ul style="list-style-type: none"> • Contour of the nasal dorsum • Shape of the nasal tip • Width of the alar base - The soft tissue contours follow the jaw movement: → Rhinoplasty can be done immediately after the jaw surgery or as part of the same surgery (technically more difficult, intubation has to be switched). - Le Fort I osteotomy rarely has a positive effect on the nose and may compromises it. In General: <ul style="list-style-type: none"> • Nasal base follows surgical movement 50%. • Nasal tip follow surgical movement 20%. - Effects of moving the maxilla up and/or forward: <ul style="list-style-type: none"> • Rotation of the nasal tip upward → deepening of the supratip depression. • Widening of the alar base. - Le Fort II and III move the nose along with the upper part of the maxilla, but the operations bear more risks than a Le Fort I.
Facial soft tissue contouring with implants	<ul style="list-style-type: none"> - Indications: <ul style="list-style-type: none"> • Paranasal deficiencies in maxillary deficiency patients. • Soft tissue deficiencies which accompany facial syndromes. - Material: <ul style="list-style-type: none"> ○ Paranasal deficiencies: <ul style="list-style-type: none"> ■ Patient's own bone. ■ Freeze-dried cadaver bone. ■ Alloplastic material (=external / inorganic material). ○ Extensive implants needed for patient with congenital anomalies are usually made from alloplastic materials that can be shaped in advance.
Lip procedures	<ul style="list-style-type: none"> - <u>Augmentation:</u> <ul style="list-style-type: none"> • Injections of collagen or other materials into the lips: Can be successful, but often it has only a temporary effect. • More stable approach: <ul style="list-style-type: none"> ○ Allo Derm (human dermis in sheet form). ○ Synthetic materials such as Gore Tex. ○ Patients' own soft tissue harvested during a simultaneous face lift procedure. → Material are threaded into a tunnel beneath the mucosa. - <u>Reduction:</u> <ul style="list-style-type: none"> • IO incisions parallel to the vermillion border and excision of soft tissue incl. submucosal glands. Removal of muscles is avoided.
Submental procedures	<ul style="list-style-type: none"> - <u>Therapeutic approaches to correct a double chin:</u> <ul style="list-style-type: none"> • Removal of excessive submental fat. • Tightening the platysma muscle sling. • Positive effects from mandibular advancement & lower border osteotomy. • Chinwing (<i>Prof. Triaca</i>)

Postsurgical stability and clinical success

<p>Important influencing factors</p>	<ul style="list-style-type: none"> - Factors influencing surgical stability in their order: <ol style="list-style-type: none"> 1. Direction of movement 2. Type of fixation 3. Surgical technique - Stability is greatest when the soft tissues are relaxed during the surgery and least when they are stretched. → Avoid stretching the pterygo-temporalis muscle sling to avoid relapse! - Mn advancement is most stable if the mn is rotated up at the gonial angle and down at the chin to decrease the stretch. - Least stable mn advancement = down rotation of the gonion angle, lengthening the ramus and upward rotation of the chin. - Neuromuscular adaptions are essentially for stability. - <u>Mx moved up:</u> <ul style="list-style-type: none"> o → Postural position of the mn alters in concert with the new mx position. o → Occlusal force ↑ = contributes to good stability of the surgery. - <u>Repositioning of the tongue to maintain airways dimensions after:</u> <ul style="list-style-type: none"> o Mn setback (no tongue reduction is needed). o Mn advancement (important for patients with sleep disorders). o Lower border osteotomy (tongue is attached to the genial tubercles). - <u>Neuromuscular adaptions do not occur when the pterygomandibular sling (elevator muscle) is stretched during mandibular osteotomy:</u> <ul style="list-style-type: none"> o Mn rotated to close an open bite. o Mn advancement. o Mn setback. <p style="text-align: center;">→ Movements of the mn that stretch the elevator muscles should be avoided.</p> - No new orientation of the muscle fibers: Neuromuscular adaption affects the length of the masticatory muscles, but not their orientation. - → Successful mn advancement requires keeping the ramus in an upright position rather than letting it incline forward as the mn body is brought forward (the same is true for the reverse). - Tendency to push the ramus intraoperative posteriorly when the chin is moved back and thus changing its orientation is a major cause of instability after operation. → When the jaw function is resumed after the operation, the orientation is restored, and the jaw moves forward again. - Stability of a 2-jaw surgery to correct a cl.III is better than mn setback alone, because it is less prone to push the mn back. - Surgical widening of the maxilla stretches the palatal mucosa and its elastic rebound is the major cause of relapse tendency. <ul style="list-style-type: none"> o Overcorrection and careful retention to avoid relapse is mandatory. o SARPE is preferred over a 3-piece approach, if no vertical or anteroposterior changes are needed.
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Surgical-Orthodontic Treatment: A Hierarchy of Stability



* Short or normal face height only

The hierarchy of stability during the *first postsurgical year*, based on data from the UNC Dentofacial Clinic, Proffit et al., 2007.

- Relapse after surgery occurs normally in a minority of patients → mean values & SD could give wrong impressions → better consider the percentage of patients with sign. changes.
- In this context:
- **Very stable:** = better than a 90% chance of no significant postsurgical change.
- **Stable:** = better than an 80% chance of no change and almost no chance of >2 mm relapse.
- **Problematic:** = some degree of relapse likely and major relapse possible.
- Key procedures in surgical treatment of class II problems are quite stable. (superior repositioning, mandibular advancement, and their combination)
- In class III treatment, maxillary advancement is the most stable procedure, while downward movement of the maxilla and mandibular setback remain problematic.
- Movement of the gonial angles down → relapse tendency ↑↑
- Moving the mn forward or back nearly always causes vertical changes:
→ The pattern of vertical change is a major determinant of postsurgical stability.
- Stability long-term 1-5 y post-op: (Proffit, 2010)
 - About 20% of the patients who had mn advancement (with or without simultaneously mx surgery), mn length decreases 1-5 y post-tx.
 - After superior positioning of the mx, downward movement of the mx, in what appears to be a resumption of the original growth pattern, leads to >2 mm change in about $\frac{1}{3}$ of the patients.
 - Clinically sign. changes in the position or dimension of the mx and mn occur in about twice as many patients as similar changes in OJ or OB.
(adaptive changes of the dentition occur to compensate for the skeletal changes)
 - Cl.III patients who tended to be less stable than cl.II patients in the first year post-surgical show less changes thereafter.

Timing of surgery	
<ul style="list-style-type: none"> - If growth modification is done early, the problems tend to recur because of later growth in the same pattern. - Usual guidance = wait until the adolescence growth spurt to start tx. - Best indication for growth stop: 3 lateral ceph's without discernable changes. 	
Progressive deformity	<ul style="list-style-type: none"> - Early surgery is required in case of a progressive deformity caused by restriction of growth e.g. ankylosis of the mandible. - Goal = Create an environment in which normal growth is possible. (not to correct the deformity) - Causes for mn asymmetry: <ul style="list-style-type: none"> o Congenital anomaly e.g. hemimandibular microsomia. o Old condylar fracture with a limitation on growth from scar tissue that limits translation of the condyle. <p>→ Indication for a surgical intervention depends on the severity of the problem.</p> - Hybrid functional appliances can help to manage an asymmetry before or after orthognathic surgery. - Hemimandibular microsomia: Timing for the distraction osteogenesis remains controversial, but social acceptability becomes a factor in the decision. → Intervention to advance the mandible often about 6-8 y of age - Hemimandibular hypertrophy: <ul style="list-style-type: none"> • Excessive growth, ø tumor: Normal hard & soft tissue in histologic diagnosis. → Just too much growth = potential to stop growing on its own. • 85% females, 15% males. • In many adolescent girls, a mild asymmetry develops as one side stops growing and the other continues for a while, but then also stops growing. • The excessive growth occurs in 2 patterns at the condyles: <ul style="list-style-type: none"> o Enlargement of the condyle. o Lengthening of the condylar neck. (seems to be more likely to stop, but no evidence) <p>and 2 patterns in terms of:</p> <ul style="list-style-type: none"> o Lengthening of the ramus versus o Lengthening the body of the mandible • Patients show all possible combinations of excessive horizontal and vertical growth. • Lengthening of the mn body ↑ → Lateral displacement of the center of the chin ↑ • Lengthening of the ramus ↑ → vertical asymmetry ↑ <ul style="list-style-type: none"> o Lower position of one side of the chin than the other. o Asymmetry at the gonial angles. o Canting of the occlusal plane → 2-jaw surgery necessary. • Removing the condyle on the affected side stops the excessive growth even though the deviant growth pattern affects the rest of the mn, not just the condyle. • Condylectomy is indicated, if the condyle no longer fits into the condylar fossa. • Condylar shave = Removal of the superior surface of the condylar neck where cellular proliferation occurs. → Can be successful if the excessive growth is an elongation of the condylar neck.
Symmetric excess growth	<ul style="list-style-type: none"> - Examples: <ul style="list-style-type: none"> o Mn prognathisme. o Mx vertical excess (long face). - Early jaw surgery has little inhibitory effect on further growth. (except condylectomy in patients with hemimandibular hypertrophy) → Delay surgery until growth is essentially completed - Assess growth status with serial ceph's. - Hand-wrist x-rays or vertebral stages are not accurate enough.

Growth deficiency	<ul style="list-style-type: none"> - Surgery can be considered earlier than in cases with excessive growth, but not before the adolescent growth spurt. - Early surgery required for: <ul style="list-style-type: none"> o Congenital problems (e.g. craniosynostosis or severe hemifacial microsomia) o Progressive deformities caused by restriction of growth (e.g. ankylosis of the mandible) - A severe, but stable deficiency is usually no indication for early surgery. → Exception: An extremely severe problem, in which preliminary orthodontic or surgical tx improve the patient's quality of life even though later operations will be needed. - Early surgery does not improve the growth prognosis (unless it relieves a specific growth restriction), nor does it produce a normal growth pattern.
1. Early mandibular advancement	<ul style="list-style-type: none"> - <u>Snow, 1991:</u> Many younger patients have further mn growth after early surgical advancement. Most of this growth is expressed vertically (not forward) and can prevent downward and backward rotation of the mn. - Early surgery before the adolescent growth spurt is not indicated for patients without progressing deformity or without severe psychosocial problems. - If facial growth declines to adult levels at the end of the adolescent growth spurt, there is no reason to delay mn advancement. <ul style="list-style-type: none"> • Only minimal facial growth can be expected in patients with severe deficiencies during late adolescence and relapse from that cause is unlikely. - 3rd molars: Removal 6 m before BSSO to facilitate the use of RIF. - <u>Proffit, 2010: Mn advancement before age 18 or later:</u> <ul style="list-style-type: none"> • Some adolescent patient had downward and backward rotation of the mn or shortening of the mn length → chin prominence ↓ = Delaying advancement probably does increase the chance of long-term stability. • The younger patients were more satisfied with their tx than those who had surgery at an older age, even though they younger patients often recognized that their chin was no longer prominent as it was shortly after surgery.
2. Early maxillary advancement	<ul style="list-style-type: none"> - Relatively stable, but further forward growth of the mx is unlikely. - Subsequent growth of the mandible is likely to result in reestablishing a class III malocclusion. - Surgical reposition of the entire mx may affect future growth. - Delay tx after the adolescent growth spurt except if tx is indicated due to psychosocial reasons. - <u>CLP:</u> <ul style="list-style-type: none"> • Surgical procedures to correct CLP do not affect future growth of the mx. • Bone graft of the alveolar cleft prior to eruption of the permanent canines: → Elimination of bony defects is possible which improves the long-term prognosis of the dentition.

Correction of combined vertical and anteroposterior problems	
Short face class II: Increasing anterior face height	<ul style="list-style-type: none"> - <u>Moving the mandible forward</u> <ul style="list-style-type: none"> • Allows a stable increase with a-p movement. • Soft tissue of the lower anterior face is stretched when the chin is advanced and moved down, but the posterior soft tissues are relaxed. - <u>Moving the maxilla down, forcing the mandible to rotate back:</u> <ul style="list-style-type: none"> • Problematic: Anterior and posterior facial soft tissues are stretched. - → The most stable type of mn advancement rotates the mn body segment as it is advanced so that the chin comes forward and downward and the mn plane angle increases.
Long face class II: Decreasing face height	<ul style="list-style-type: none"> - <u>Moving the maxilla up → mandible can rotate up and forward:</u> <ul style="list-style-type: none"> • Most stable orthognathic procedure. • Produces a change in the postural position of the mandible: = neuromuscular adaption. • If the mn is still deficient after it has rotated up and forward, a mn advancement in combination with the mx procedure does not stretch the muscles and is acceptably stable. - <u>Mandibular ramus osteotomy:</u> <ul style="list-style-type: none"> • Unstable: Mandibular elevator muscles are stretched and do not adapt.
Short face class III: Increasing anterior face height	<ul style="list-style-type: none"> - Mandibular ramus osteotomy (MRO). - + Maxillary osteotomy if downward movement of the maxilla is desired.
Long face class III: Decreasing face height	<ul style="list-style-type: none"> - Maxillary osteotomy. - + Mandibular ramus osteotomy if setback or further advancement of the mandible is needed.

Special points in planning orthognathic surgery

- Incision lines contract during healing:
 - Stress of the gingival attachment if they are placed in the vestibule.
 - Consider gingival grafting before genioplasty if the attached gingiva is inadequate.
- Removal of 8-8 should be done 6 m before mn ramus surgery if RIF is planned.
- Unpredictable impact of orthognathic surgery on TMD.
 - TMJ disorders are usually improved during presurgery orthodontics, but only transient.
 - If TMJ surgery along with mx/mn surgery is planned, defer it better after orthognathic surgery.
→ The outcome of TMJ surgery is more predictable if the new joint positions and occlusal relationships have been established.
- Definitive restorative and prosthetic tx is the last step after surgery.
- Mx advancement widens the nostrils and tends to tip the nasal tip up.

Putting surgical and orthodontic tx together: Who does what, when?

Orthodontic appliance considerations	<ul style="list-style-type: none"> - Function of the orthodontic appliance: <ul style="list-style-type: none"> ○ Perform tooth movements needed for the surgery preparation. ○ Stabilization of the teeth and basal bone at the time of surgery and during healing (less important now with rigid internal fixation). ○ Provide attachments for intermaxillary fixation. ○ Postsurgical tooth movement while retaining the surgical correction. - Any variation of the 18 or 22 slot edgewise is acceptable for stabilization, including self-ligating brackets if they allow a full size wire to be ligated. - <u>Ceramic brackets:</u> Susceptible to fracture, only exceptionally on teeth 321+123. - <u>Lingual appliances:</u> Some attachments on the facial surface of the teeth must be placed for temporary intermaxillary fixation. - <u>Clear aligners:</u> <ul style="list-style-type: none"> ○ Buccal attachments are necessary for surgery. ○ 2 sets of aligners necessary: presurgical & postsurgical.
Goals of presurgical treatment	<ul style="list-style-type: none"> - (I) Place the teeth in relation to their own bone without regard to the occlusion and (II) make the arches compatible. - No need for preoperative tooth movements if they can be accomplished more easily and quickly during or after the operation. <ul style="list-style-type: none"> ○ Extrusion is in general more easily to perform postsurgically. ○ Intrusion must be accomplished presurgically or handled surgically. - Presurgical phase should not require > 1 y. Exception: Delay caused by waiting for growth to be completed.
Steps in orthodontics for preparation of surgery	<ul style="list-style-type: none"> - <u>Leveling the mandibular arch:</u> The desired final face height decides about intrusion or extrusion to level an accentuated curve of Spee. <ul style="list-style-type: none"> • Intrusion: <ul style="list-style-type: none"> ○ Correction presurgical or during surgery with a subapical osteotomy to depress the lower incisor segment. ○ Segmented arch approach is indicated. • Extrusion: <ul style="list-style-type: none"> ○ More easily performed postsurgically, except the lower face height is not allowed to increase ○ Levelling after surgery occurs rapidly because the teeth are not in contact. ○ Deep bite - short face patients: Alignment is better performed after surgery. - <u>Leveling the maxillary arch:</u> <ul style="list-style-type: none"> • Severe vertical discrepancies within the mx arch are an indication for multiple segment surgery: <ul style="list-style-type: none"> ○ The upper arch should not be levelled conventionally. ○ Avoid extrusion of the anterior teeth. → A small orthodontic relapse could create a postsurgical open bite.

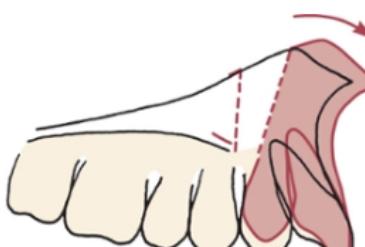
Establishment of the incisor position and space closure	<ul style="list-style-type: none"> - Mandible: The anteroposterior position of the incisors determines where the mandible will be placed relatively to the maxilla at surgery. - Maxilla: If several surgical segments are planned, the axial inclination of the upper incisors and canines should be established presurgically so that major rotation of the anterior segments at surgery can be avoided. → Intraoperative rotation of the anterior segment to maintain the vertical position of the mx incisors, while their inclination is changed, tends to elevate the canine off the occlusal plane and diverge the roots at the osteotomy site.  <ul style="list-style-type: none"> - If the extraction site is the location of an osteotomy cut, don't close it completely. (leave room for interdental cuts)
Surgery first without any presurgical orthodontics	<ul style="list-style-type: none"> - The approach was evaluated and discarded in the 1970s, but reintroduced recently. - Pros: <ul style="list-style-type: none"> o Faster tx because segmental osteotomies could be used to accomplish much of the presurgical tooth movement. o Teeth close to the osteotomy sites might move more rapidly. (regional acceleration of bone remodeling) o Patients are happy because their major problem would be addressed first and tx is shorter. - Contras: <ul style="list-style-type: none"> o The surgical procedures and postsurgical orthodontics are more difficult. o Limitations in anteroposterior changes because of the lack of presurgical decompensation of the incisors' position. o Longer postsurgery orthodontics makes patients unhappy with surgical tx. - No good evidence for the advantages → Apply with care. - <i>Hernandez-Alfaro, 2014:</i> Patients with severely crowded teeth or deep bite are not good candidates for surgery first.

TABLE 20.1 Sequence of Surgical–Orthodontic Treatment

Consensus Sequence	Surgery First
Orthodontic plan, preliminary surgical plan	3-D imaging (?), surgical plan, postsurgical orthodontic plan, splints
Presurgical orthodontics	Orthodontic appliance only, no surgical stabilizing archwire
Final surgical plan	
Orthodontic surgical procedure with final, intermediate (?) splints	Orthognathic surgery, dentoalveolar surgery, corticotomy (?), intermediate and final splints, temporary anchorage devices (TADs) for postsurgical orthodontics
Minimal postsurgical orthodontics, 3–6 months	Extensive (bone screws or miniplates) for postsurgical orthodontics

Stabilizing arch wires	<ul style="list-style-type: none"> - Should be in place 4 weeks before surgery so that they are passive when the impressions for the splint are taken. - Full dimension wires: 22-slot: 21x25 TMA or ss. - Should contain hooks to tie the jaws together. - Surgery first approach: <ul style="list-style-type: none"> • No archwires at the operation, but an orthodontic appliance has been placed so that the archwires or archwire segments can be placed at the operation or soon afterwards. • Orthodontic tx begins during the 1st week postsurgical usually.
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Patient management at operation and postoperative care	
Final surgical planning	<ul style="list-style-type: none"> - Presurgical records: <ul style="list-style-type: none"> • OPG, lateral cephalometric, dental casts mounted in a semiadjustable articulator. • Periapical x-rays of osteotomy sites. • CBCT indicated if a jaw asymmetry has to be corrected. - Surgical movements and resulting soft tissue changes are evaluated using a cephalometric or CBCT. - Surgical models are duplicated → virtual or actual model surgery → fabrication of the dental splints.
Splints and stabilization	<ul style="list-style-type: none"> - Interocclusal wafer splint made from the casts repositioned by the model surgery. - As thin as consistent with adequate strength: Never more than 2 mm thick at the thinnest point. - When the lower arch has not been leveled presurgically, some teeth can contact through the splint. - The splint stays in place during initial healing (typically 2 weeks). - Don't remove the splint immediately after the use in the operation room. - Splint should allow good access to the teeth for oral hygiene and permit lateral movements during jaw function. - Replace the stabilizing wires with lighter and more flexible archwires at the same time as the splint is removed. Patient is positioned in RK und may has only a few contacts → Risk of a slide to find a more convenient bite which can make orthodontics more difficult and stress surgery sites.
Postsurgical care	<ul style="list-style-type: none"> - Time at the hospital: <ul style="list-style-type: none"> • Lower border osteotomy: No overnight stay. • Maxillary osteotomy: No overnight stay. • Bimaxillary surgery: 1 night stay. (can be at a surgical center, not necessarily at a hospital) - Normally little use of pain medication: <ul style="list-style-type: none"> • Operations involving the mandibular ramus require about the same amount of pain medication as extraction of impacted wisdom teeth. • Mx procedures are tolerated better than that. - Early return to jaw movements eliminates the discomfort. - <u>Diet:</u> <ul style="list-style-type: none"> • <u>1st week soft diet:</u> Milkshakes, potatoes, scrambled eggs... • <u>2-3rd w:</u> Soft food that requires some chewing: pasta, meat in pieces... • <u>6-8th w:</u> Back to the normal diet. • Degree of discomfort can be used as guide to the progression rate. - <u>Physical therapy</u> <ul style="list-style-type: none"> • Start as soon as the postsurgical intracapsular joint edema is resolved. • <u>1-2nd w:</u> 3 x 10-15 min sessions of opening and closure exercises + lateral movements with closing into the splint. • <u>3-8th w:</u> Range of motion should be increased. • <u>8th w postop:</u> Normal function should be achieved.
Postsurgical orthodontics	<ul style="list-style-type: none"> - Start when the splint is removed and the working wires are replaced by light wires. <ul style="list-style-type: none"> • → A flexible rectangular wire in the upper arch to maintain torque control of the maxillary incisors often is a good choice with a round wire in the lower jaw: 22 slot: mx 21x25 M-NiT, mn 16 ss. The opposite is possible if more mx tooth movement than mn tooth movement is needed. • Light vertical elastics are needed initially to override proprioceptive impulses from the teeth that otherwise would cause the patient to seek a new position of maximum intercuspal occlusion. • Removing the splint without allowing the teeth to settle into better interdigitation can result in the patient adopting an undesirable convenience bite. → Orthodontics can be complicated and risk for stress to the surgical sites.

	<ul style="list-style-type: none">- Use light vertical elastics to close the bite with the working wires until the occlusion is settled.<ul style="list-style-type: none">• 1-4th w postsurgery: 4/4 incl. eating• 4-8th w postsurgery: 4/4 without eating• 8-12th w postsurgery: 2/4- Postsurgical orthodontics should not take >6 m: → Patients are intolerant for longer tx afterwards.- <u>Retention:</u><ul style="list-style-type: none">• Same retention like for adult patients with orthodontic tx.• Surgical maxilla expansion requires minimum 6 months fulltime retention. If a transpalatal bar was placed, it should not be removed during the first postsurgical year.
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Discussion with Dr. Gkantidis 09.05.2017

- Body dysmorphic disorder:
Psychological disorder. Whatever you do to the patients, they will ask for more.
 - High palatal vault → easier to expand → prefer Le Fort 1 + 3-piece to SARPE.
 - Low risk for hemorrhage after SARPE or Le Fort 1.
 - Wait 3 weeks to perform sport post-operative (12 weeks for contact sport).
 - Antibiotics for 7 days perioperative. After that, infections occur rarely.
 - 3-6w 100% work incapability.
- SARPE vs. 3-Piece
- | | | |
|--|--|---|
| | SARME
- Reduced morbility (?)
- Reduces need for extractions
- Less operator-sensitive | LF I - 3
- More precise positioning segments
- Allows other movements maxilla |
| | - Reduced control position segments
- Extra-surgery | - Possible need for extractions
- Increased morbility (?)
- Limit to expansion (c.a. 7mm) |

- The aging face:

Männer	Frauen
Profil wird gerader	Profil wird nicht gerader
Lippen werden retrusiver	Lippen werden nicht retrusiver
Nase wird grösser in allen Dimensionen	Nase wird auch grösser in allen Dimensionen aber weniger ausgeprägt
Kinn wird prominenter	Pogonion wird reduziert

- Shape of the Nose: (Chaconas, 1969)

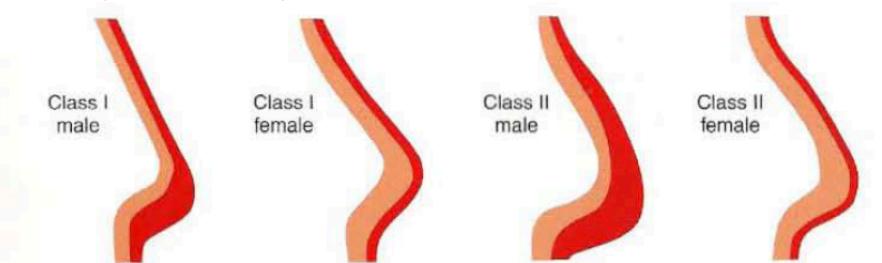


Fig. 4-7 Patterns of nasal growth, based on cephalometric data from the Bolton growth study (i.e., longitudinal data for white children of northern European descent). Note that both males and females show more growth in vertical height than anteroposterior projection of the nose, but downward growth is greater in males. Boys have an adolescent growth spurt in nose length, whereas girls often do not. A dorsal hump in the nose often develops when Class II malocclusion is present and is more pronounced in boys. (From Chaconas SJ: A statistical evaluation of nasal growth, *Am J Orthod* 56:403-414, 1969.)

- Nose:
 - o Tip follows surgical movement 20%
 - o Base follow surgical movement 50%

→ Mx advancement or set up widens the nose.
- Genioplasty:
 - o Maximum augmentation = 6 mm
 - o Maximum reduction is limited by the length of the roots of the teeth.

- Mx down positioning
 - o Stability is problematic due to changes within the first few postsurgical weeks before bone healing is complete, as occlusal force tends to push it upwards.
 - o Approaches to maintain the position:
 - Heavy rigid fixation (more than screws and plates).
 - Rigid graft.
 - Simultaneous mn surgery to decrease the occlusal force.
- *Triaca*:
 - OSAS: Minimum 10 mm mn advancement required to achieve a positive effect on the respiration.
 - Distraction is recommended if mn advancement > 8 mm.
 - Botox application before and after BSSO can reduce relapse tendency from 10-50% to 5%.
- Fewer patients exhibit long-term changes in the dental occlusion than skeletal changes, because adaptive changes often occur in the dentition when skeletal changes occur.

Soft Tissue/Hard Tissue Ratios, Manual Prediction

Treatment	Soft Tissue Change	Notes
Anteroposterior movement of incisors: maxillary or mandibular, forward or back, surgical or orthodontic	60% to 70% of incisor movement	1, 2
Vertical movement of incisors	Minimal unless jaw rotates	3, 4, 5
Mandibular advancement	Soft tissue: chin 1:1 with bone, lower lip; 60% to 70% with incisor	6
Maxillary advancement	Nose: slight elevation of tip Base of upper lip: 20% of point A Upper lip: 60% of incisor protraction, shortens 1 to 2 mm	7, 8
Mandibular setback	Chin: 1:1 Lip: 60%	5
Maxillary setback	Nose: no effect Base of upper lip: 20% of point A Upper lip: 60% of incisor Advancement lower lip: variable, may move back	3
Mandibular setback plus maxillary advancement	Changes similar to a combination of the two procedures separately	
Maxillary superior repositioning	Nose: usually no effect Upper lip: shortens 1 to 2 mm Lower lip: rotates 1:1 with mandible	7
Mandibular advancement plus maxillary superior repositioning	Chin: 1:1 Lower lip: 70% of incisor Upper lip: shortens 1 to 2 mm 80% of any incisor advancement Nose: slight elevation of tip	9
Mandibular inferior border repositioning	Soft tissue forward: 60% to 70% bone Chin: Up—1:1 with bone Back—50% bone Laterally—60% bone Down—?	

From Proffit, White¹.

1. Little difference with surgery or orthodontics.
2. If both upper and lower incisors are retracted (bimaxillary protrusion), lip movement stops when lips come into contact.
3. Lip shortens 1 to 2 mm with vestibular incision (more if surgical technique is poor).
4. Lip rotates with mandible 1:1.
5. If face height increases, lip may uncurl and lengthen.
6. If lip uncurls, it will go forward less.
7. Nose change is usually temporary.
8. Less soft tissue change occurs after cleft lip repair.
9. Data from Jensen AC, Sinclair PM, Wolford LM: Soft tissue changes associated with double jaw surgery, *Am J Orthod Dentofac Orthop* 101:266-275, 1992.

Presurgical Versus Postsurgical Orthodontics

Procedure	Comment
NECESSARY BEFORE SURGERY	
Alignment	Primarily by tipping: flexible round wire (16 mil austenitic NiTi best)
Intrusion (leveling)	Segmented arch technique required; stabilizing lingual arches needed; Burstone depressing arch (17 × 25 TMA or steel) suggested
Arch compatibility	Be careful regarding: Second molars' vertical position (Don't elongate upper second molars!) Canine widths
BEFORE AND/OR AFTER SURGERY	
Posterior crossbite correction	No orthodontic expansion before surgery in a patient who will have surgical expansion OK to leave up to half-cusp crossbite for correction after surgery
Extrusion (leveling)	Easier and more efficient after surgery; partial leveling with continuous archwires can be done before surgery
NECESSARY AFTER SURGERY	
Extrusion (settling, leveling)	Should complete in 4 to 6 months
Root paralleling at osteotomy sites	
Detailed tooth positioning	