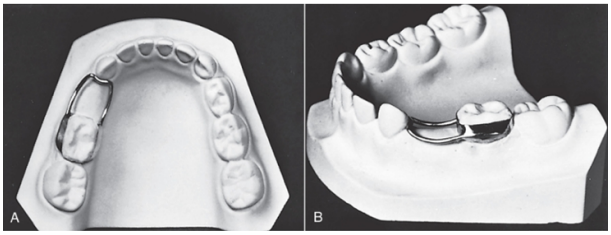
Space maintenance after premature tooth loss

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

1. Band-and-loop space maintainer

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



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

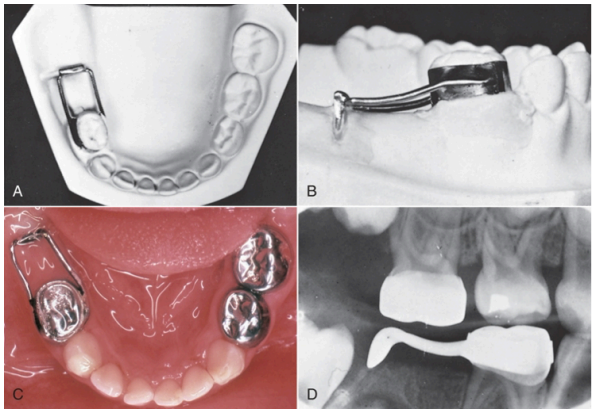
2. Partial denture space maintainers

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

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

3. Distal shoe space maintainer

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



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

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

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

Discussion 24.01.2017

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

Proffit Chapter 12:

Complex Nonskeletal Problems in Preadolescent Children:

Preventive and Interceptive Treatment

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

Type 1

Type 2

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

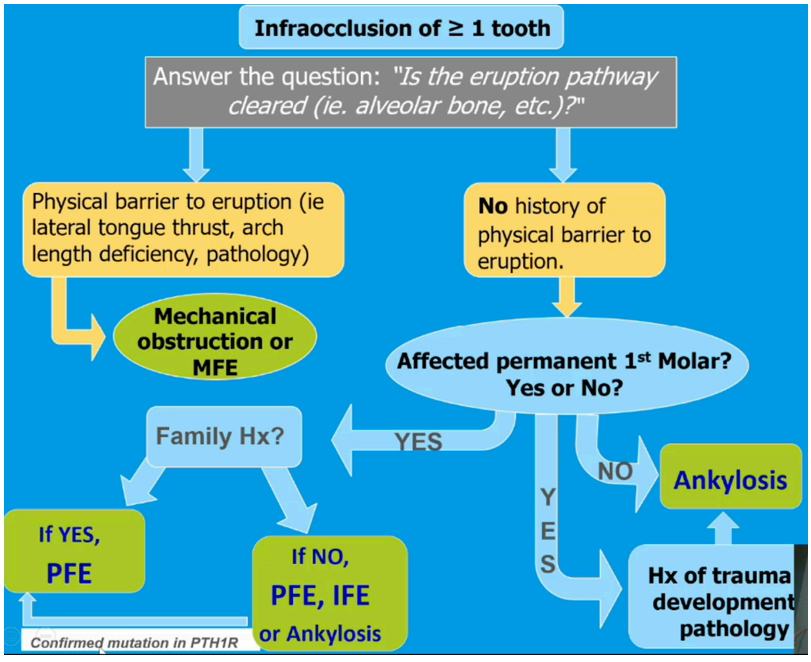
     PTHr is secreted during tooth movement from:
     - Adrenal gland ?
     - Fibroblasts
     - Rest of the Hertwig epithel board
     - Outer enamel epithel
  3. Osteoblasts release RANKL
  4. Activation of osteoclasts via RANKL/RANK System.

→ PFE: PTHR1 configurations changes → ø osteoclast activation.

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

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

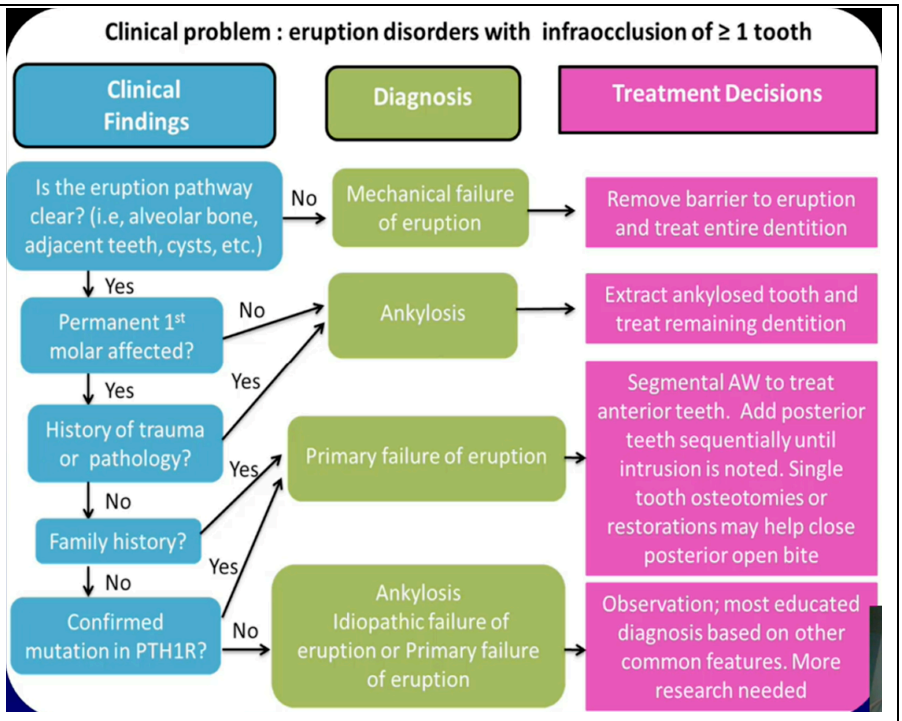
- Diagnosis:
  - Family history (genetic component) → check parents / siblings.
  - Genetics: Mutation of PTH1R.
  - Phenotype & Genotype correlation.
  - Predominantly posteriore teeth involved, including primary teeth.
    → Ankylosed primary molars could be an indicator of PFE.
    → Anterior teeth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



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

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

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

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

Traumatic displacement of teeth www.dentaltraumaguide.org

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

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

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

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

Space related problems

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

Excess space

1. Spacing of permanent teeth

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

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

2. Maxillary dental protrusion and spacing

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

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

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

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

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

3. Missing second premolars

- Differentiate delayed forming vs. missing premolars!

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

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