Eruption and Shedding of Teeth

Tooth eruption is the process by which developing teeth emerge through the soft tissue of the jaws and the overlying mucosa to enter the oral cavity, contact the teeth of the opposing arch, and function in mastication. Therefore, it is a continuous process.

Phases of tooth eruption:

Preeruptive phase: All movements of primary and permanent tooth germ (crowns) from time of their early initiation and formation to the time of crown completion.

Eruptive phase: Starts with initiation of root formation and made by teeth to move from its position within bone of the jaw to its functional position in occlusion. Has an intraosseous and extraosseous compartments. 4 stages: root formation, movement, penetration, and occlusal contact.

Posteruptive phase: Takes place after the teeth are functioning to maintain the position of the erupted teeth in occlusion while the jaws are continuing to grow and compensate for occlusal and proximal tooth wear.

Mixed Dentition: Presence of both dentitions

Remember that during all these 3 stages is the progression that happens from primary to permanent dentition which involves the shedding (exfoliation) of primary teeth.

Dentition:

Diphodont: two sets of dentition in humans
Primary vs Secondary dentition
Deciduous vs Permanent dentition
Mixed dentition: presence of two dentition

Teeth in primary dentition are smaller and fewer in number than permanent dentition to conform to the smaller jaw size.

Primary dentition: ~ 2 to 6 years of age
Mixed dentition: ~ 6 to 12 years
Permanent dentition: > 12 years

Pre-eruptive tooth movement: Why do developing crowns move constantly in the jaws during the preeruptive phase?

To place teeth in position for eruptive tooth movement:

1. To alleviate the problems of jaw growth which allows second molar to move backward and anterior teeth to move forward.

2. Developing crown move constantly during the preeruptive phase as they respond to positional changes of the neighboring crowns and to changes in the mandible and maxilla.

3. Permanent teeth develop lingual to the incisal level of the primary anterior teeth and later as primary teeth erupt, the permanent crowns are lingual to the apex 3rd of primary roots.

4. Permanent premolars move from occlusal level of primary molars to a position enclosed within the primary tooth roots.

5. All movements in the preeruptive phase occur within the crypts of the developing crowns.
Two types of tooth movement in pre-eruptive phase:

1. Total bodily movement
2. Movement where one part remains fixed while the rest continues to grow leading to change in the center of the tooth germ

Eruptive Tooth Movement

4 major events occur:

1. Root formation. Space is required for root formation; proliferation of epithelial root sheath; initiation of root dentin and pulp; increase in fibrous tissue of the follicle
2. Movement. Occurs incisally or occlusally; the main reason for movement is so that the roots can form normally; reduced enamel epithelium fuses and contacts the oral epithelium
3. Penetration of the tooth’s crown tip through the fused epithelial layers allowing entrance of the crown into the oral cavity
4. Intraoral incisal or occlusal movement of the erupting tooth continues until clinical contact with the opposing crown occurs
Stages of tooth eruption

Clinical crown: During eruption, the exposed crown extending from the cusp tip to the area of the gingival attachment

Anatomic crown: Entire crown, extending from cusp tip to the cementoenamel (CE) junction

Histology – changes that occur in tissues overlying erupting teeth

Degeneration of connective tissue (decrease in blood vessels and degeneration of nerves) immediately overlying the erupting teeth

Eruption pathway – altered tissue area overlying the teeth

Macrophages destroy cells and fibers by secreting hydrolytic enzymes

Gubernacular cord: The connective tissue overlying a successional tooth that connects with the lamina propria of the oral mucosa by means of a strand of fibrous connective tissue that contains remnants of dental lamina

Gubernacular canal: Holes noted in a dry skull noted lingual to primary teeth in jaws that represent openings of gubernacular cord

As the successional teeth erupt, gubernacular canal widens enabling tooth to erupt
Histology – Surrounding tissues

The surrounding fibers change from being parallel to the tooth surface to bundles that are attached to the tooth surface and extending towards the periodontium (bone).

The periodontal ligament have contractile properties and changes drastically during eruption.

During eruption, collagen fiber formation and turnover are rapid enabling fibers to attach and release and attach in rapid succession. Some fibers may attach and reattach later while the tooth moves occlusally as new bone forms around it and the fibers will organize and increase in number and density as the tooth erupts.

Histology – Underlying tissues

As the tooth moves occlusally it creates space underneath the tooth to accommodate root formation.

Fibroblasts around the root apex form collagen that attach to the newly formed cementum.

Bone trabeculae fill in the space left behind as the tooth erupts in the pattern of a ladder which gets denser as the tooth erupts.

After tooth reaches functional occlusion periodontal fibers attach to the apical cementum and extend into the adjacent alveolar bone.

The rate of tooth eruption depends on the phase of movement.

Intraosseous phase: 1 to 10 µm/day

Extraosseous phase: 75 µm/day

Environmental factors affecting the final position of the tooth:

Muscular forces

Thumb-sucking
Eruption is a multifactorial process.

The accepted theories of tooth eruption are:

1. **Root Formation.** Should be an obvious cause of tooth eruption. But studies have not provided evidence for this. If a tooth that is continuously erupting (rodent incisor and guinea pig molar) is prevented from forming its root, the root still forms by causing bone resorption. Rootless teeth still erupt, some teeth erupt more than the total length of the roots, and the teeth still erupt after completion of root formation. Therefore root formation is accommodated during eruption and may not be the cause of tooth eruption.

One point of importance is that the tissue beneath the growing root resists the apical movement of the developing root. This resistance results in the occlusal movement of the tooth crown as the root lengthens.

2. **Bone Remodeling.** Major proof is when a mand PM is removed without disturbing its follicle or you wire down the tooth germ, an eruptive pathway still forms within bone as osteoclasts widen the gubernacular canal. If the dental follicle is also removed no eruption path develops. So not sure if bone remodeling plays a significant role but is involved.

One point to remember: Bone formation also occurs apical to the developing tooth.

3. **Dental Follicle.** Studies have shown that the reduced dental epithelium initiates a cascade of intercellular signals that recruit osteoclasts to the follicle. By providing a signal and chemotaxant for osteoclasts, it is possible that the dental follicle can initiate bone remodeling which goes with tooth eruption. Teeth eruption is delayed or absent in animal models and human diseases that cause a defect in osteoclast differentiation.

4. **Periodontal ligament.** Formation and renewal of PDL can be a factor in tooth eruption because of the traction power of the fibroblasts. However, presence of PDL does not always correlate with tooth eruption. Other factors involved are vascular pressures within the PDL. Examples of PDL being present but tooth not erupting and rootless teeth erupting have been reported.

**Post Eruptive Tooth Movement**

1. Movements to accommodate the growing jaws. Mostly occurs between 14 and 18 years by formation of new bone at the alveolar crest and base of socket to keep pace with increasing height of jaws.

2. Movements to compensate for continued occlusal wear. Compensation primarily occurs by continuous deposition of cementum around the apex of the tooth. However, this deposition occurs only after tooth moves. Similar to eruptive tooth movement.

3. Movements to accommodate interproximal wear. Compensated by mesial or approximal drift. Mesial drift is the lateral bodily movement of teeth on both sides of the mouth. Very important in orthodontics.

Several factors control mesial drift:

(a) Contraction of the transseptal fibers: As the proximal tooth surfaces of adjacent teeth become worn from functional tooth movement, the transseptal fibers of the periodontal ligament become shorter (due to contraction) and thereby maintain tooth contact.

(b) Adaptability of bone tissue: The side of pressure on PDL fibers causes bone resorption, whereas pull on the fibers causes bone apposition (formation). Therefore, as the contact areas of the crowns wear, the teeth tend to move mesially, thereby maintaining contact.

(c) Anterior compartment of occlusal force: An anteriorly directed force is generated when teeth are clenched, due to the mesial inclination of most teeth and the forward-directed force generated from inter-cuspal forces. Eliminating opposing teeth results in elimination of biting forces, causing a slowing down of the mesial migration.

(d) Pressure from soft tissues: Buccal mucosa and tongue push teeth mesially.

Active eruption: to compensate incisal and occlusal wear

Passive eruption: gradual recession of the gingiva and the underlying alveolar bone

Both active and passive eruption leads to shortening of the clinical crown.
Shedding of Teeth

1. Osteoclast/bone remodeling
2. Odontoclast (cementoclast; dentinoclast)
3. Resorption of soft tissues

Pressure from successional teeth

Figure Source: Dr. Sandra Meyers

Osteoclasts are bone resorbing cells derived from monocyte-macrophage lineage

Giant multinuclear cells with 4-20 nuclei

Osteoclasts resorb hard tissue by separating mineral from the collagen matrix through the action of hydrolytic enzymes

Resorption occurs at the ruffled border which greatly increases the surface area of the osteoclast in contact with bone

Hard Tissue resorption:
1. Extracellular phase
2. Intracellular phase

Osteoclasts

- Resorb bone
- Large and multinucleated
- Derived from pluripotent hematopoietic cells in the bone marrow that also give rise to monocytes and macrophages
- Produce tartrate-resistant acid phosphatase (TRAP)

Shedding of mandibular incisor

Figure Source: Dr. Sandra Meyers

Deciduous 2nd molar

Figure from Ten Cate's Oral Histology, 6th edition
Shed element following "shedding of primary incisor"

- Complete resorption of roots
- Resorption lacunae seen (arrow)
- Most of coronal pulp is intact

Figure Source: Dr. Sandra Meyers

7 years-functional occlusion attained but root apex is still not fully formed

15 years - incisal wear

Figure Source: Dr. Sandra Meyers

Problems of Primary Tooth Eruption

- Natal and Neonatal Teeth

Retained Primary teeth

Submerged primary teeth

- Ankylosed Teeth
- Submerged Teeth
- Hyper or supra eruption

Ankylosis

Source: Color atlas of clinical oral pathology. Neville, Damm and White. 2nd edition
Congenitally Missing Teeth

Cleidocranial Dysplasia

Osteopetrosis – Defect in Osteoclasts