Dr. Al-Hussein Ali

Second stage - Al Ameed University

College of Dentistry 2024-2025

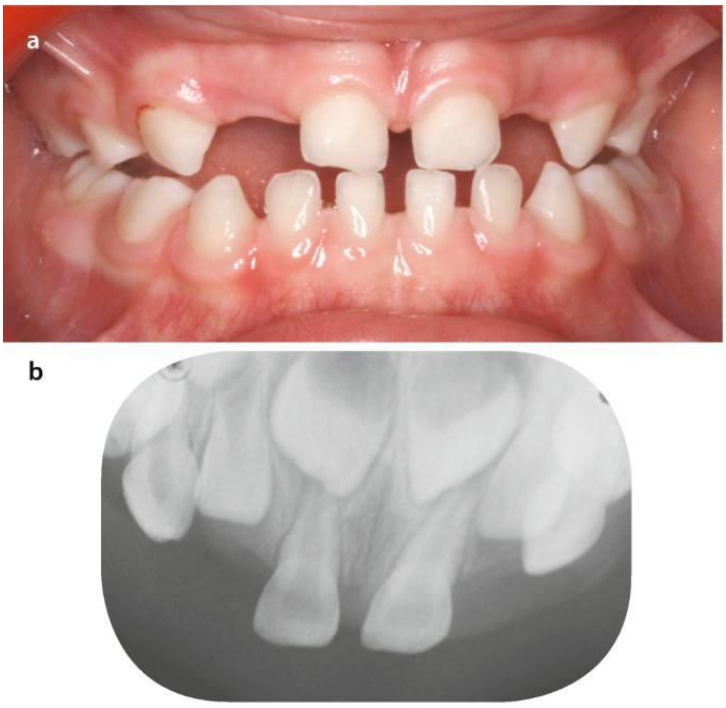
Tooth eruption

Eruption is a physiological process by which tooth is moving from its developmental position inside the jaw to the functional position in the mouth (functional occlusion).

The occlusal movement of the tooth is the '**active eruption',** while the gradual exposure of the crown by the apical shift or recession of the gingiva is the **passive eruption.**

The movement of the tooth occlusally begins soon after root formation is initiated.

Eruption takes place in chronological order.



Primary (baby) teeth erupt into the mouth from around 6 months until 2 years of age.

These teeth are the only ones in the mouth until a person is about 6 years old.

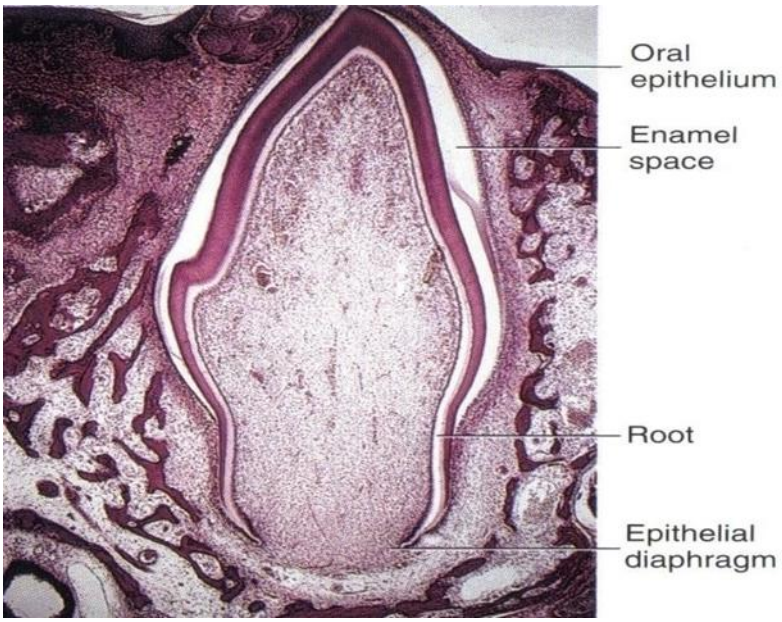
Patterns of tooth movement:

1. **Pre-eruptive tooth movement:** Made by the deciduous and permanent tooth germs within the jaw before they begin to erupt. During this stage the tooth germ increases in size due its rapid growth, resulting in crowding of the teeth especially in the incisors and canine regions. This crowding is then relieved by growth of the jaws, which permits drifting of the tooth germ.

The permanent tooth germs first develop lingual to their predecessor in the same bony crypt. The premolar tooth germs, also in the same bony crypts, finally are positioned between the divergent roots of the deciduous molars.

The permanent molars developed from the backward extension of dental lamina as described previously.

2. **Eruptive tooth movement:** Made by a tooth to move from its position within the bone crypt to its functional position in occlusion. The direction of movement is occlusal or axial.

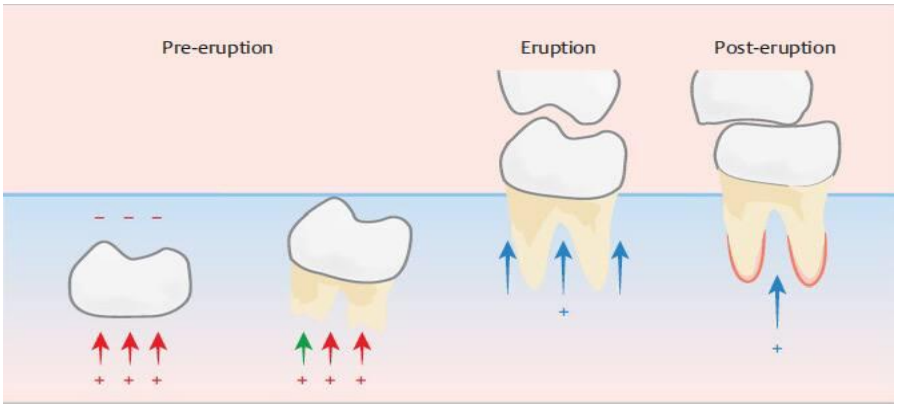


3. Post-eruptive tooth movement: It is necessary to:

A. To maintain the position of erupted tooth while the jaw continues to grow.

B. Compensate for occlusal and proximal wear

The movement occurs in axial direction to keep pace with increase in the height of the jaw. It involves both the tooth and its socket when the jaw growth is completed. The movement is compensating for occlusal and proximal wear. It continues throughout life and consists of axial and mesial migration respectively.



Types of movements of tooth during the three phases of eruption:

1. Axial or occlusal: In the direction of the long axis of the tooth.
2. Bodily drifting: There is a shift of entire tooth germ in the mesial and distal direction. There is a resorption in direction of tooth movement and bone deposition from behind.
3. Tilting or tipping: Tilting of tooth along its transverse axis.
4. Rotation: Movements of tooth along its long Axis.
5. Excentric growth: This type of movements or growth results in one side of tooth germ grows while other side remains fixed with shift of central axis. As the crown enlarges, it grows more in one area than in another.

During movements 1-4 bone resorption is occurring in the direction of movements and bone deposition occurs in opposite direction.

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Histology of the eruption:

There are three phases:

1. Pre-eruptive phase:

a. Made by the deciduous and permanent teeth germ within the tissue of the jaw before they begin to erupt. This phase starts at early bell stage till the beginning of root formation.

b. It involves bodily drift and excentric movements.

c. Requires remodeling of the bony wall of the crypt. This is done by osteoclasts and osteoblasts activity.

d. The permanent teeth also undergo movement to bring them in correct position for eruption.

Permanent incisors and canines first developed lingual to deciduous teeth then they move to more apical position as their deciduous erupts.

2. Eruptive phase:

a. This phase starts at the beginning of root formation and ends when the tooth has reached the occlusal plane. The movements are occlusal, drifting, tilting, and rotating.

b. During this phase the tooth moves from its position within the bony crypt to its occlusal position. As the tooth erupts it is still covered with a layer of reduced enamel epithelium which represents the remaining layers of the enamel organ.

The importance of reduced enamel epithelium **(REE)** for the process of eruption:

i. Produces proteolytic enzymes like collagenase which disintegrate the connective tissue present on the path of eruption pathway.

ii. The REE fuses with the oral epithelium lining the oral cavity.

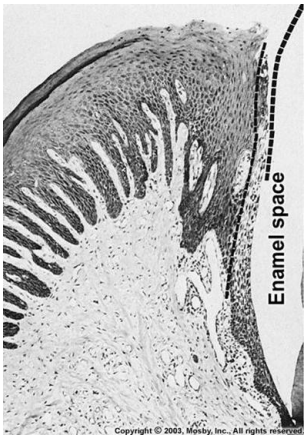
iii. The REE produces enzymes which disintegrates the central portion of this fused tissue – results in an epithelial tunnel through which the tooth erupts.

This disintegration results in an inflammatory response – explained as the teething response

As the tooth erupts, the portion of the epithelium covering the crown pulls back and exposes the crown.

The cervical portion of the epithelium is still attached to the neck of the tooth (se figure below)

This fused tissue serves as the **initial junctional epithelium (thin dotted line**) and creates a seal between the tooth and the surrounding tissue.



- Root completion continues for some time after the teeth come into occlusion, this process takes from 1-1.5 years in primary teeth and 2-3 years in permanent teeth.
- Dentinogingival apparatus (DJA) formation: As eruptive movement begins; the crown is covered by **reduced enamel epithelium (REE). Following emergence, the teeth erupt at maximum rate to reach the occlusal plane and meet their antagonists, and they** continue to erupt at slow rate to compensate jaw growth and occlusal wear.

  After emergence, the part of the oral surrounding the neck of tooth is termed gingival, and the REE is forming an epithelial seal called the junctional epithelium of the DJA.

3. Post-eruptive phase:

This phase begins when the tooth has reached its occlusal plane and terminates at the end of the life span of the tooth. During this phase an axial and drifting movements are responsible for:

a. maintains the position of the tooth while the jaw continues to grow. Post eruptive movements that accommodates the growth of the jaws are completed towards the second decade (14-18 years of age). This growth is associated with the growth of mandibular condyle. It is also associated with the remodeling of the alveolar bone and periodontal ligament.

b. compensates for occlusal wear: Is achieved by continued cementum deposition around the apex of the tooth. It is also involving the occlusal movement of the tooth.

c. to accommodate for interproximal wear: Wear also occurs at the contact points between teeth, on their proximal surfaces. The interproximal wear is compensated by a process known as mesial or proximal drift. Mesial drifts are important for orthodontics.

Mechanism of eruption

The mechanisms involved in the eruption are likely to be a combination of a number of factors. Many theories have been proposed for that.

1. **Bone remodeling**: This theory suggests that bone remodeling achieved by the formation and resorption of bone around a tooth produce a pulling force to the tooth. It is important to permit for tooth movement. Selective bone deposition and resorption occur around developing tooth during eruption. The arguments against this theory mentioned that:

- Bone deposition at the bottom of the crypt during eruptive phase occurs only after the tooth has moved
- When eruption is prevented by pinning a developing tooth to the bone, or by removing a developing tooth while leaving the dental follicle intact, the eruptive pathway forms in the overlying bone.

Thus, it is generally accepted that the bone remodeling is the result and not the cause of tooth movement.

2. **Root formation theory:**

Root formation appears to be the obvious cause of tooth eruption. It would be expected that the onset of root formation and eruptive movement would coincide, but this does not occur. Initial root formation results in bone resorption at the base of the socket, because when growth pressure is applied to bone, it is removed by osteoclast action. It is therefore be concluded that some force other than root growth is moving the tooth to erupt. Clinical observations also indicate that root formation cannot be responsible for eruptive tooth movement. For instance, some teeth move a distance greater than the length of their roots, rootless teeth erupt,

also, eruptive movements can occur after completion of root formation or when the tissues forming the root are surgically removed.

3. Vascular hydrostatic pressure:

This theory considered that the arterial pressure in the periapical tissue moves the tooth, but this pressure is limited and surgical excision of the root and associated tissue eliminates the principle vasculature, it did not stop eruption. This means that the local increase in the vascular pressure is not absolutely necessary for tooth eruption.

4. Periodontal ligament traction:

This theory suggests that contraction of fibroblasts or collagen fibers in the PDL produce a pulling (tractional) force onto the tooth. The collagen fibers provide the contractile force for eruption. And the fibroblast act as a contractile cell (due to its content of contractile protein as actin and myosin). In this way the fibroblasts will pull on collagen fibers of PDL, which are firmly attached to the bone.

Recent studies and observations suggested that:

- Rootless teeth erupt.
- Impacted teeth with PDL do not erupt.
- PDL fibroblast contain little actin and myosin, and large amounts of rough endoplasmic reticulum
- Thus, the PDL is not the major factor in tooth eruption, but may have in late post-eruptive movement.

5. Dental follicle:

This theory suggests that the dental follicle has an important participation in tooth eruption.

a. The dental follicle regulates the alveolar bone resorption needed for formation of eruption pathway ahead of advancing tooth.

b. Dental follicle provides a factor called colony-stimulating factor-1 (CSF-1), which is maximally expressed in the dental follicle at day 3, it was hypothesized that CSF-1 down-regulates the influx of monocytes which are needed to be differentiated into osteoclasts. Thus the dental follicle serves as a target to attract the monocytes, whereby these cells fuse to form osteoclasts.

c. The blood supply of dental follicle will be the source of monocytes, which will be transformed into osteoclast.

d. The follicle also provides the osteoblasts that form bone trabecullae apical to the tooth.

e. The follicle provides the fibroblasts that will form the periodontal ligaments.

*Removal of developing tooth, but the dental follicle left intact, the eruptive pathway forms in the overlying bone. On the other hand, if the dental follicle is removed, no eruptive pathway forms.

* In osteopetrotic animals (with skeletal sclerosis), which lacks a factor (CSF-1) that stimulates osteoclasts differentiation, eruption is prevented, because no eruptive pathway forms.

Thus, removal of the dental follicle prior to the onset of eruption prevented the unerupted tooth from erupting.

In conclusion these observations clearly prove that the process of eruption is a multifactorial process, and the PDL traction is the most important factor in tooth eruption.

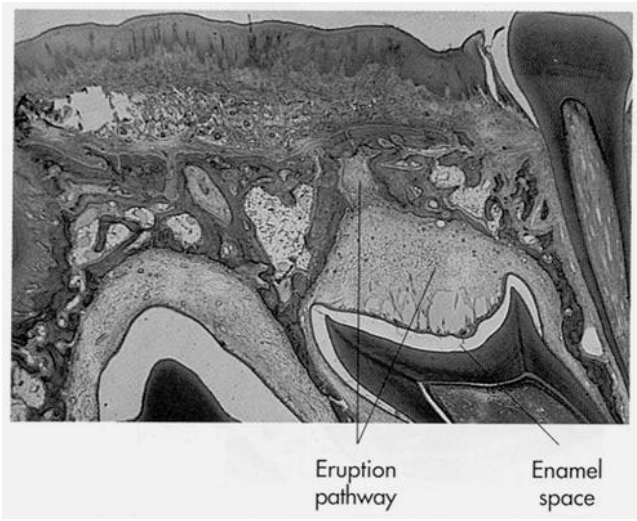
Eruption of secondary teeth:

The process of eruption of secondary teeth varies slightly from that seen in eruption of primary teeth. The dental follicle that surrounds the secondary tooth is still in connection with **remaining of the dental lamina**. This remains of the dental lamina and the surrounding connective tissue is known as **gubernacular cord,** which resides in the gubernacular canal. The gubernacular cord is extending from the reduced enamel epithelium to the

lamina propria of oral mucosa. The gubernacular cord may have an influence on eruptive tooth movement. When secondary tooth first developed it was sharing a common bony crypt with its predecessor. As the deciduous tooth erupts the permanent tooth germ becomes situated apically and is entirely enclosed by its own bony crypt. It has been proposed that during eruption of secondary tooth, the **gubernacular cord undergoes contraction to assist in**:

- In occlusal movement of the toot.
- Guiding the permanent tooth as it erupts.

In the dried skull, holes can be found in the alveolar bone just lingual to the primary anterior teeth, these holes are the opening of gubernacular canals.



Essentials of Oral Histology and Embryology. James Avery, 2nd edition

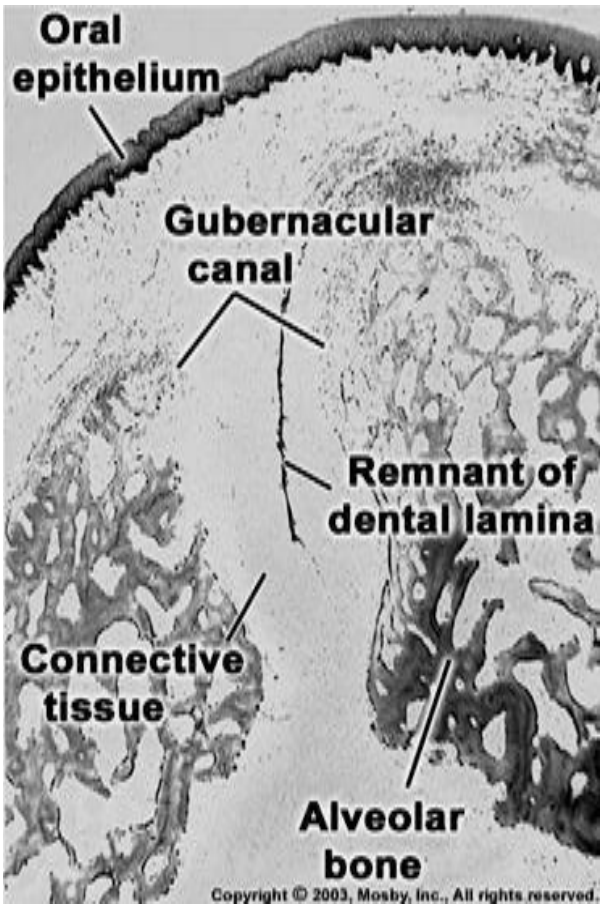
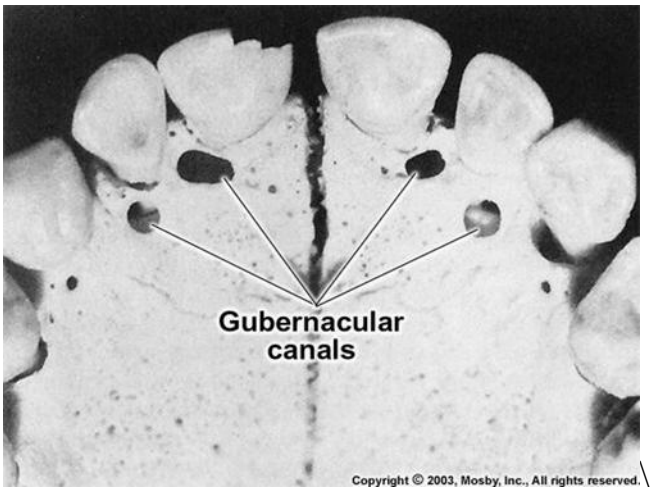


Figure from Ten Cate's Oral Histology, Ed., Antonio Nanci, 6th edition



The rate of tooth eruption depends on the phase of movement

Intraosseous phase: 1 to 10 µm/day

Extraosseous phase: 75 µm/day

The environmental factors affecting the final position of the tooth:

a. Muscular forces

b. Thumb sucking

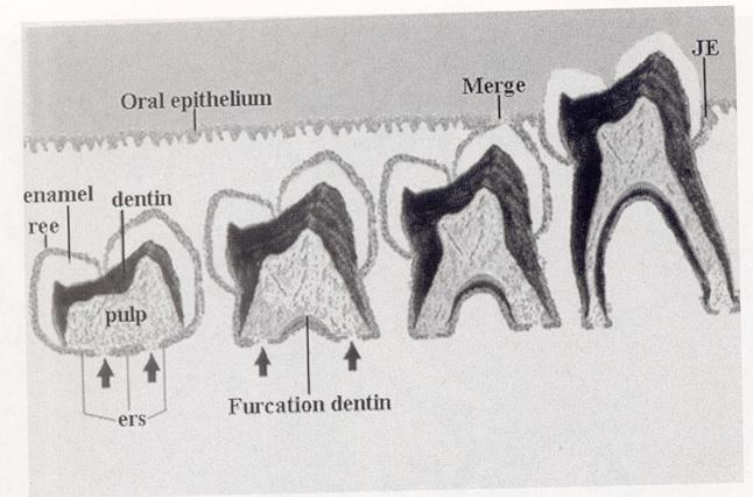
Why hemorrhage does not occur during eruption?

Both the reduced enamel epithelium and the oral epithelium begin to proliferate and migrate into the connective tissue between them, so that a solid plug of epithelium forms in advance of the erupting tooth. The central cells of the epithelial mass degenerate and form an epithelial lined canal through which the tooth erupt without any hemorrhage.

Clinical considerations:

The eruption of teeth is part of general development and growth; therefore, it may be considered as a biological test of growing individual.
Retarded eruption is more common than premature or accelerated eruption.

Disturbances of eruption may have local or systemic causes.



What Causes Delays in Tooth Eruption?

Tooth eruption may be delayed for several reasons, including (but not limited to) the following:

1. **A family trait:** Sometimes when a parent and/or sibling have both experienced delayed tooth eruption, it is due to a trait that just runs in the family. This is a very common cause for delayed tooth eruption.
2. **Genetic developmental disorders:** Down's Syndrome, hypopituitarism, and other genetic disorders that impact physical development may slow down the eruption of teeth.
3. **Nutritional deficiencies:** When children are vitamin D deficient and/or not getting enough nutrients, they may have slower growth tendencies.
4. **Dental conditions:** Infections, poor spacing in the mouth, and/or deformities within the mouth impact the tooth's eruption causing delays and sometimes the need for extraction(s).
5. **Low birth weight and/or premature birth:** Studies have shown that babies with a low birth weight and babies that are born prematurely may experience delays in tooth eruption.

• Local causes of delayed eruption:

1. Premature loss of deciduous tooth.
2. Fibromatosis gingiva.
3. Ankylosis of root and bone.
4. Tooth germ is missing.
5. Sever trauma may eliminates the dental follicle.
6. Drifting of opposing teeth which block the eruptive pathway.

• Systemic causes:

1. Endocrine disturbances (hypothyroidism, hypopituitarism).
2. nutritional deficiency (protein, Vitamin D).
3. Genetic disorder.