Al Rasheed College of Dentistry
Oral Histology
Dr. Omar Faridh Fawzi
Lecture 3

Tooth development

Bell stage

As the invagination of the epithelium deepens and its margins continue to grow, the enamel organ assumes a bell shape. In the bell stage crown shape is determined. It was thought that the shape of the crown is due to the pressure exerted by the growing dental papilla cells on the inner enamel epithelium. This pressure however was shown to be opposed equally by the pressure exerted by the fluid present in the stellate reticulum.

The folding of enamel organ to cause different crown shapes is shown to be due to differential rates of mitosis and differences in cell differentiation time. Cells begin to differentiate only when cells cease to divide. The inner enamel epithelial cells which lie in the future cusp tip or incisor region stop dividing earlier and begin to differentiate first. The pressure exerted by the continuous cell division on these differentiating cells from other areas of the enamel organ cause these cells to be pushed out into the enamel organ in the form of a cusp tip. The cells in another future cusp area begin to differentiate, and by a similar process results in a cusp tip form. The area between two cusp tips, i.e. the cuspal slopes extent and therefore of cusp height are due to cell proliferation and differentiation occurring gradually from cusp tips to the depth of the sulcus. Cell differentiation also proceeds gradually cervically, those at the cervix are last to differentiate.

Four different types of epithelial cells can be distinguished on light microscopic examination of the bell stage of the enamel organ. The cells form the ***inner enamel epithelium, the stratum intermedium, the stellate reticulum, and the outer enamel epithelium.*** The junction between inner and outer enamel epithelium is called ***cervical loop*** and it is an area of intense mitotic activity.

Inner enamel epithelium

The inner enamel epithelium consists of a single layer of cells that differentiate prior to **amylogenesis** into tall columnar cells called **ameloblasts**. These elongated cells are attached to one another by junctional complexes laterally and to cells in the stratum intermedium by desmosomes. The cells of the inner enamel epithelium exert

an organizing influence on the underlying mesenchymal cells in the **dental papilla**, which later differentiate into **odontoblasts**.

Stratum intermedium

A few layers of squamous cells form the stratum intermedium between the inner enamel epithelium and the stellate reticulum. These cells are closely attached by desmosomes and gap junctions. Desmosomal junctions are also observed between cells of stratum intermedium, stellate reticulum and inner enamel epithelium. The well-developed cytoplasmic organelles, acid mucopolysaccharides, and glycogen deposits indicate a high degree of metabolic activity. This layer seems to be essential to enamel formation. It is absent in the part of the tooth germ that outlines the root portions of the tooth which does not form enamel.

Stellate reticulum

The stellate reticulum expands further, mainly by an increase in the amount of intercellular fluid. The cells are star shaped, with long processes that anastomose with those of adjacent cells. Desmosomal junctions are observed between cells of stellate reticulum, stratum intermedium and outer enamel epithelium. Before enamel formation begins, the stellate reticulum collapses, reducing the distance between the centrally situated ameloblasts and the nutrient capillaries near the outer enamel epithelium. Its cells then are hardly distinguishable from those of the stratum intermedium. This change begins at the height of the cusp or the incisal edge and progresses cervically.

Outer enamel epithelium

The cells of the outer enamel epithelium flatten to a low cuboidal form. At the end of the bell stage, preparatory to and during the formation of enamel, the formerly smooth surface of the outer enamel epithelium is laid in folds. Between the folds the adjacent mesenchyme of the dental sac forms papillae that contain capillary loops and thus provide a rich nutritional supply for the intense metabolic activity of the avascular enamel organ. This would adequately compensate the loss of nutritional supply from dental papilla owing to the formation of mineralized dentin.

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Dental lamina

The dental lamina is seen to extend lingually and is termed successional dental lamina as it gives rise to enamel organs of permanent successors of deciduous teeth. The enamel organs of deciduous teeth in the bell stage show successional lamina and their permanent successor teeth in the bud stage.

Dental papilla

The dental papilla is enclosed in the invaginated portion of the enamel organ. Before the inner enamel epithelium begins to produce enamel, the peripheral cells of the mesenchymal dental papilla differentiate into **odontoblasts** under the organizing influence of the epithelium. First, they assume a cuboidal form later they assume a columnar form and acquire the specific potential to produce dentin. The basement membrane that separates the enamel organ and the dental papilla just prior to dentin formation is called the membrana preformativa.

Dental sac

Before formation of dental tissues begins, the dental sac shows a circular arrangement of its fibers and resembles a capsular structure. With the development of the root, the fibers of the dental sac differentiate into the **periodontal fibers** that become embedded in the developing **cementum and alveolar bone**.

Advanced bell stage

This stage is characterized by the commencement of **mineralization** and **root formation**. During the advanced bell stage, the boundary between inner enamel epithelium and odontoblasts outlines the future **dentine-enamel junction**. The formation of dentin occurs first as a layer along the future dentine-enamel junction in the region of future cusps and proceeds to the pulp and apically. After the first layer of **dentin** is formed, the ameloblast which has already differentiated from **inner enamel epithelial** cells lay down enamel over the dentin in the future incisal and cuspal areas. The enamel formation then proceeds coronally and cervically, in all regions from the dentine-enamel junction (DEJ) towards the surface. In addition, the cervical portion of the enamel organ gives rise to the epithelial root **sheath of Hertwig**. **The Hertwig's** epithelial root sheath (HERS) outlines the future root and is thus responsible for the shape, length, size, and number of roots.

CLINICAL CONSIDERATIONS

A lack of initiation results in the absence of either a single tooth or multiple teeth **(partial anodontia)**, most frequently the permanent upper lateral incisors, third molars, and lower second premolars. There also may be a complete lack of teeth **(anodontia)**. On the other hand, abnormal initiation may result in the development of single or **multiple supernumerary teeth**.

In vitamin A deficiency the ameloblasts fail to differentiate properly. Consequently, their organizing influence on the adjacent mesenchymal cells is disturbed, and atypical dentin, known as **osteodentin** is formed.

Endocrine disturbances affect the size or form of the crown of teeth if such effects occur during **morphodifferentiation**, that is, in utero or in the first year of life. Size and shape of the root, however, may be altered by disturbances in later periods. Clinical examinations show that the retarded eruption that occurs in persons with hypopituitarism and hypothyroidism results in a small clinical crown that is often mistaken for a small anatomic crown. Abnormal curvatures in the root, termed **dilacerations** may be due to trauma sustained during development of the root.

Disturbances in morphodifferentiation may affect the form and size of the tooth without impairing the function of the ameloblasts or odontoblasts. New parts may be differentiated like formation of **supernumerary cusps or roots**. Twinning, i.e. two similar teeth may be produced as a result of splitting of one tooth germ. Fusion of teeth produced from two tooth germ joined together before mineralization may occur. A suppression of parts may occur like loss of cusps or roots. An abnormality in shape may result in a peg or malformed tooth with enamel and dentin that may be normal in structure. **Peg shaped teeth (screw-driver shaped)** with the permanent upper central incisor showing a notched incisal edge may be seen in individuals born with congenital syphilis. This condition is known as **Hutchinson's incisor**.

Genetic and environmental factors may disturb the normal synthesis and secretion of the organic matrix of enamel leading to a condition called **enamel hypoplasia**.

If the organic matrix is normal but its mineralization is defective, then the enamel or dentin is said to be **hypocalcifie or hypomineralized**. Both **hypoplasia** and **hypocalcification** can occur as a result of an insult to the cells responsible for the apposition stage of tooth development.

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