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Embryology and Anatomy of the Jaw and Dentition

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Radiologists should possess working knowledge of the embryological development and anatomy of the jaw and dentition in order to aid in the diagnosis of both simple and complex disorders that affect them. Here, we review the elaborate process of odontogenesis, as well as describe in detail the anatomy of a tooth and its surrounding structures.
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With the ever-increasing sophistication of cross-sectional imaging techniques in the evaluation of head and neck pathology, including multidetector computed tomography (CT) and cone-beam CT with improved contrast and spatial resolution, as well as dental CT software programs,[1,2] radiologists are charged with the accurate identification of abnormalities of the teeth and jaw. A working knowledge of the development and anatomy of teeth is critical in understanding and describing the disease processes that affect them.

Embryology

The structures of the head and neck are derived from the cephalic portion of the neural tube, which gives rise to the 5 pairs of branchial arches. Each arch consists of 3 layers: an outer ectoderm, a middle layer composed of mesenchyme-containing neural crest cells, and an inner layer of endoderm. The development of the face starts at the fourth week of embryonic age with the stomodeum, a ventral depression located just caudal to the developing brain, which develops into the mouth. Surrounding the stomodeum are 5 primordia. These include the single frontonasal process (prominence) located at midline and cranial to the stomodeum, followed caudally by the paired maxillary and mandibular processesly-ing on each side of the stomodeum. The frontonasal process originates from the forebrain. The maxillary and mandibular processes are derived from the first branchial arch (also referred to as the mandibular arch) and form the lateral wall and base of the stomodeum. By the fifth week, medial and lateral nasal processes develop on either side of the frontonasal process. The medial nasal processes fuse to form the upper lip. The mandibular processes enlarge and fuse at midline to form the mandible, the lower part of the face, and the tongue. The skeleton of the mandible is derived from the cartilaginous derivative of the first branchial arch called Meckel's cartilage. The mandibular mentum marks the site where the 2 mandibular processes merge in the midline. By the sixth week, the bilateral maxillary and mandibular processes are completely fused, forming the primitive maxilla and the mandible. When the maxillary and mandibular processes fuse laterally, they form the corners of the lips, or commissures. Any interruption or alteration of the development of the face and the jaw can result in congenital anomalies. For example, failure of proper closure at the midline can result in cleft lip, cleft chin, or cleft palate. Interruption of lateral fusion of the maxillary and mandibular processes can result in cleft corners of the mouth or macrostomia (large mouth).

Ectomesenchyme, a derivative of neural crest cells, forms the bony structures of the head and face. The muscles of mastication are formed from the mesenchymal cells of the first branchial arch. The stomodeum, which forms the primitive oral cavity, is lined by stratified squamous epithelium called oral ectoderm. At approximately the sixth week, the oral ectoderm proliferates into a thick band of epithelium called the primary epithelial band. This horseshoe-shaped structure develops into the alveolar processes of the upper and the lower jaws. The primary epithelial band develops into the vestibular lamina and the dental lamina. The vestibular lamina develops into the vestibule between the cheek and the alveolar process. The dental lamina, a thickening of the oral epithelium overlying the jaws, forms the basis of development of dentition.

The process by which the teeth form is called odontogenesis (Fig. 1). Humans have 2 sets of teeth, the temporary baby, or deciduous, teeth and the permanent adult, or succedaneous,

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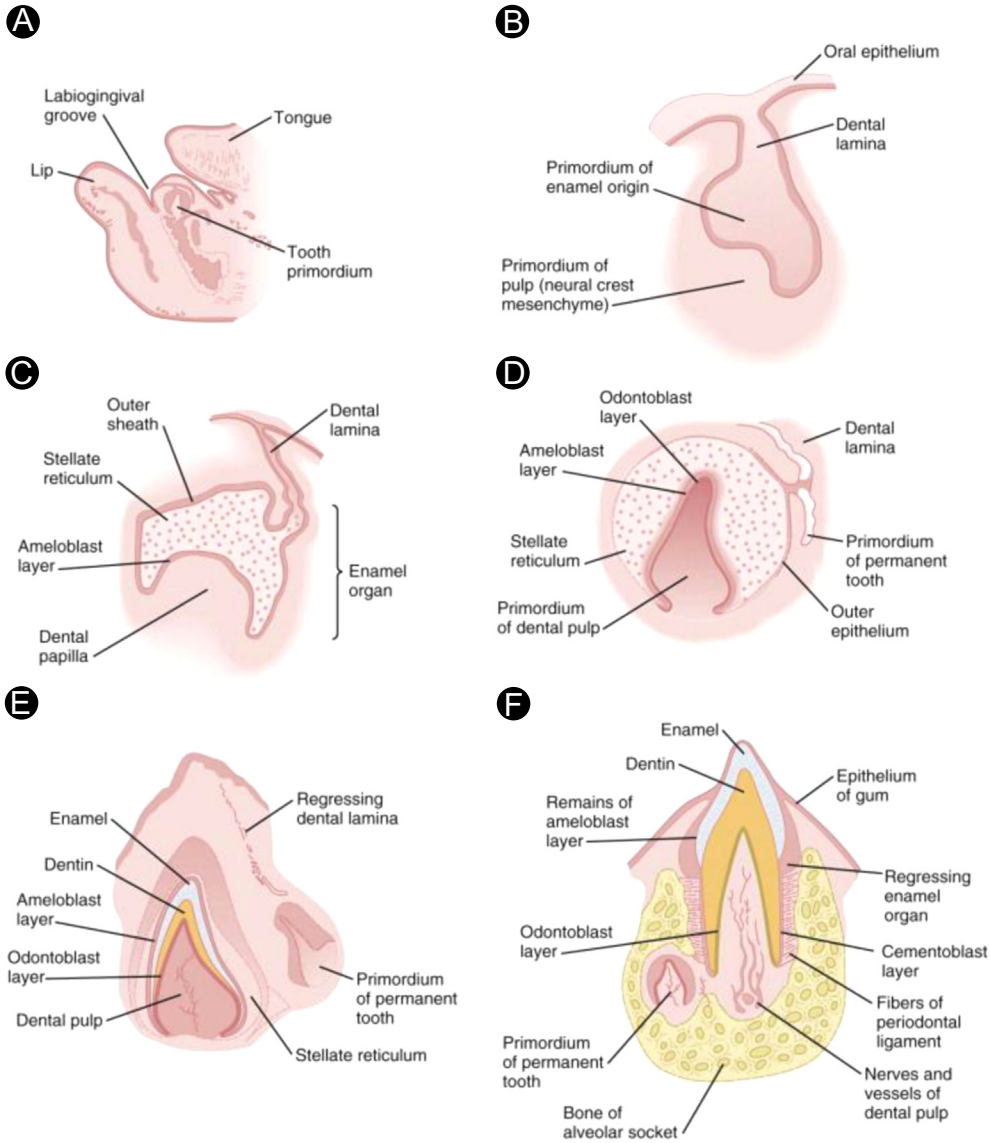

Figure 1 The development of a deciduous tooth. (A) A parasagittal section through the lower jaw of a 14-week-old human embryo showing the relative location of the tooth primordium. (B) Tooth primordium in a 9-week-old embryo. (C) Tooth primordium at the cap stage in an 11-week-old embryo, showing the enamel organ. (D) Central incisor primordium at the bell stage in a 14-week-old embryo before deposition of enamel or dentin. (E) Unerupted incisor tooth in a term fetus. (F) Partially erupted incisor tooth showing the primordium of a permanent tooth near one of its roots. (Adapted with permission from Carlson.[5]) (Color version of figure is available online.)

teeth. There are 20 deciduous teeth (10 maxillary and 10 mandibular) and 32 succedaneous teeth. Deciduous teeth begin development at the sixth- to eighth-week of gestation, and permanent teeth begin development at the twentieth week. Each tooth develops from the ectoderm (enamel) and the ectomesenchyme (dentin, cementum, periodontal ligament, and pulp contents). Ectomesenchyme represents migration of neural crest cells into the developing arches of the mandible and the maxilla. Tooth development begins with the localized proliferation of the primary dental lamina invaginating into the ectomesenchyme, forming focal thickenings of the oral epithelium called placodes in 10 places in each of the mandibular and the maxillary arches.[3-7] These placodes develop into tooth buds, which later develop into individual teeth. The tooth buds and surrounding aggregation of ectodermal cells constitute the tooth germs. During embryologic development, the deciduous teeth are formed starting from the anterior aspect of the maxilla and the mandible and proceeding posteriorly. Each tooth develops and erupts at a different time, although the pattern of odontogenesis is the same[5] (Table). The tooth buds of the permanent teeth are arranged in a horseshoe-shaped arch, lingual to the deciduous teeth. All tooth buds, except for the second and third permanent molars, are present and start developing before birth. The major activity of the dental lamina extends over a period of approximately 5 years. However, the dental lamina near the third molar continues to be active until approximately 15 years of age.

As the tooth bud grows, it assumes a cap shape by invagination of the mesenchyme. The ectodermal component