DEVELOPMENT OF DENTAL ARCH AND OCCLUSION

The stage sequence of dental arch development is the same for everyone. At birth, the alveolar ridges are plain firm tissue with no teeth on them. As the child grows steady changes are seen both on and within the ridge. The alveolar ridge grows and enlarges while the teeth develop to attain their final shape and size within the jaws.

The first primary tooth to erupt is the central incisor at about 7½ months, and the last to erupt is the second primary molar at about 2½ years. Closure of the root apex occurs at 3 years for the second primary molar. The usual sequence of primary dentition eruption is the central incisor (in Palmer notation, designated by the letter A), the lateral incisor (B), the first primary molar (D), and the canine (C), followed by the second primary molar (E). Hence, the typical eruption sequence is A-B-D-C-E.

Development of occlusion can be divided into the following developmental periods:

1. Pre-dental/dentate period: This is the period after birth during which the neonate does not have any teeth. It usually lasts for 6 months after birth. The characteristic feature is the alveolar ridge that are called gum pads. The upper anterior gum pad (intercuspid width) is typically wider than the lower anterior pad, and the upper anterior gum pad protrudes (overjet) about 5 mm relative to the lower anterior gum pad. The upper anterior gum pad usually overlaps (overbite) the lower anterior pad by about 0.5 mm. In the first 6 months of postnatal life, there is marked palatal width increase, and the overjet decreases rapidly. Gum pad relationships at birth cannot be used as reliable diagnostic criteria for predicting subsequent arch relationship. The primacy of life-supporting functions (i.e., respiration and swallowing) is so great at birth that major unpredictable adjustments in maxillary and mandibular positions take place in the first few years of life.
2. The deciduous dentition period: The initiation of primary tooth buds occurs during the first six weeks of intrauterine life. The primary teeth begin to erupt at the age of about 6 months. The eruption of all primary teeth is completed around 3 years of age when the second deciduous molars come into occlusion and their roots complete development. By 3 years of age, however, the relationship of maxilla to mandible is well established, and the overall maxillomandibular pattern does not change significantly thereafter.
3. The mixed dentition period: The mixed dentition period begins at approximately 6 years of age with the eruption of the first permanent

molars. During the mixed dentition period, the deciduous teeth along with some permanent teeth are present in the oral cavity.

4. The permanent dentition period: This period is characterized by the presence of all permanent teeth.

Ideal occlusion at a young age predisposes to an ideal adult occlusion. The most desirable occlusion in the permanent dentition is a Class I interdigitation, and certain features in the primary and mixed dentitions, if observed accurately, can provide clinical clues as to whether a Class I relationship of the dentition will eventually develop. The major difference between ideal adult and child occlusions is the teeth present. By 7 years of age, the primary central and lateral incisors have been or are in the process of being replaced by their permanent successors, and the permanent first molars are already erupted. The primary dentition remaining usually includes the canine and first and second molars of both arches.

Criteria for ideal dental occlusion for a 7-year-old child might include the following:

- Class I molar and canine interdigitation
- 2-mm anterior and posterior overjet
- 2-mm anterior overbite
- Coincident dental midlines

Deciduous Dentition Period

The characteristic features of deciduous dentition period are as follows:

1. Spacing in deciduous dentition

It is very common to find physiological spaces in the primary dentition, with the most prevalent spaces mesial to the primary canine in maxilla and distal to the primary canine in mandible. These spaces are called the "primate spaces" or "anthropoid spaces" which are helpful in canine positioning and relationship with opposing arches. Two consistent morphologic arch forms of the primary dentition:

- (Type I): generalized spaces between the teeth were present
- (Type II): teeth were in proximal contact without spacing

The arch form in both types appears congenital rather than developmental because the original pattern exhibited upon eruption was maintained from ages 3 to 6 years. Until the eruption of the permanent first molars, the sagittal dimension of the primary dental arches remained essentially unchanged, with the possible exception of a slight decrease as a result of the development of dental caries on the proximal surfaces of the molar teeth. Only minor changes in the transverse dimension of the primary dental arches occurred during 3–6 years of age unless negatively influenced by deleterious functional patterns.

The other spaces in primary dentition are called the developmental spaces which play an important role in the development of permanent dentition. Some children do not have such physiological spaces thereby referred to as closed space or non-spaced dentition. Such dentition is highly prone to malocclusion during the development of permanent dentition.

2. Shape of dental arch

In deciduous dentition, the dental arch are wider and almost in wide 'U' shape with spaces visible between teeth.

3. Terminal plane relation of the deciduous molars

The relationship of the distal terminal planes of opposing second primary molar teeth can be classified into one of three categories:

- A flush terminal plane (flush terminus) means that the anteriorposterior positions of the distal surfaces of opposing primary second molars are in the same vertical plane.
- A mesial-step terminus is defined as a lower second primary molar terminal plane that is mesial to the maxillary primary terminus.
- The distal-step terminal plane is a situation in which the mandibular second primary molar terminus is distal to the upper second primary molar terminus.

4. Deep bite
5. Flat curve of Spee
6. Shallow cuspal interdigitation
7. Incisors are more vertically placed

Mixed Dentition Period

The mixed dentition period can be divided into three phases:

1. First transitional period
2. Inter transitional period
3. Second transitional period

1. First transitional period

The first transitional period is characterized by the emergence of the first permanent molars and the exchange of the deciduous incisors with the permanent incisors.

a) Eruption and occlusion of first permanent molar

The mandibular first molar is the first permanent tooth to erupt at around 6 years of age. The location and relationship of the first permanent molar depends much upon the distal surface relationship between the upper and lower second deciduous molars. The first permanent molars are guided into the dental arch by the distal surface of the second deciduous molars. The deciduous molar relation determines the permanent molar relation as the

later erupts into occlusion. Three distinct kinds of molar adjustment can occur:

- Mesial shift during first permanent molar eruption occurs at the expense of any posterior spacing that might have been present including breakdown spaces resulting from interproximal caries, proximal breakdown of the tooth crown and/or premature loss of the primary teeth. The occlusion forming a mesial step (distal surface of the lower second primary molar is mesial to the same surface of the maxillary molar) is most ideal for Class I development.
- A distal step (distal surface of the lower second primary molar is distal to the same surface of the maxillary molar) indicates a developing Class II malocclusion.
- Proper permanent molar occlusion was achieved from a straight terminal plane by a second mesial shift of the molars as second primary molars are exfoliated. This "late" shift of the mandibular first molar, often under the additional influence of the emerging second permanent molar, occurs at the expense of the leeway space with a decrease in the attendant arch length of 2–3 mm on average.

b) Exchange of incisors

During the first transitional period the deciduous incisors are replaced by the permanent incisors. The mandibular central incisors are usually the first to erupt. The permanent incisors are considerably larger than the deciduous teeth they replace. This difference between the amount of space needed for the accommodation of the incisors and the amount of space available for this is called incisal liability. The incisal liability is roughly about 7 mm in the maxillary arch and about 5 mm in the mandibular arch.

The mean increase in the intercanine width was greater in the maxillary arch (3-4 mm) than in the mandibular arch (2-3 mm). In the mandibular arch, the greatest tendency to increased width was during eruption of the lower lateral incisors, whereas in the maxillary arch, it occurred primarily during eruption of the maxillary central incisors. Although the increase was slightly greater in non-spaced primary arches than in spaced arches, the arches with spaces generally resulted in a favorable alignment of the permanent incisors. About 40% of the arches without primary dental spacing resulted in crowded anterior segments.

The regulatory factors controlling the arrangement of the four permanent incisors is as follows:

1. Utilization of the physiologic spaces that exists in the primary dentition.
2. Increase in the intercanine width.
3. Increase of anterior length in the dental arch will provide space to accommodate the larger permanent incisors.

4. Both maxillary and mandibular permanent incisors show labial inclination much more than primary incisors making the permanent dental arch circumference wider for the arrangement of larger permanent incisor.

Increase in the maxillary and mandibular arch width occurs between 6 weeks and 2 years of age. The mandibular intercanine width is established by 8 years of age (i.e., after eruption of the four incisors) and although the arch width increased between 3 and 13 years of age, there is a slight decrease in width, more in the intercanine than in the intermolar area, after complete eruption of the permanent teeth. Incisor alignment patterns and intercanine arch dimensions are essentially established by 8 years of age.

2. Intertransitional period.

It is a relatively lag phase with no active tooth movements to occur. The dental arches are comprised of both primary and permanent teeth. The maxillary and mandibular arches consist of permanent incisors and permanent molars that sandwich the deciduous canines and molars. This phase lasts for 1.5 years and is relatively stable. Only a few changes in the morphology of deciduous teeth are seen because they undergo attrition

3. Second transitional period

The second transitional period (also known as the late mixed dentition) between 9-12 years of age involves the exfoliation of the primary canines and molars in conjunction with the eruption of the permanent canines, premolars and second permanent molars.

a. Exchange of canines and premolar.

The space available for the canine and premolars is limited as the mesial surface of the first permanent molar forms its distal limit and the distal surface of the permanent lateral incisor forms its mesial limit. The factors to be considered during this period are:

1) Leeway space of Nance
2) Ugly duckling stage.

1) Leeway space of Nance

The combined mesio-distal width of the permanent canines and premolars is usually less than that of the deciduous canines and molars. The surplus space is called Leeway space of Nance. The amount of leeway space is greater in the mandibular arch than in the maxillary arch. It is about 1.8 mm (0.9 mm on each side of the arch) in the maxillary arch and about 3.4 mm (1.7 mm on each side of the arch) in the mandibular arch. This excess space available after the exchange of the deciduous molars and canines is utilized for mesial drift of the mandibular molars to establish class I molar relation.

The most favorable dental arch pattern is one in which leeway space is excessive (i.e., combined size of unerupted canine and premolars is smaller than arch space available). If leeway space is deficient, dental arch crowding predictably results. Average growth changes in the dental arch are not great enough to compensate for leeway deficiencies.

2) **Ugly duckling stage**

Also called Broadbent phenomenon. The term ugly duckling stage indicates the unaesthetic appearance of child during this stage. It is a transient or self-correcting malocclusion seen in the maxillary incisor region between 8-9 years of age, seen during the eruption of the permanent canines. As the developing permanent canines erupt, they displace the roots of the lateral incisors mesially. This results in transmitting of the force onto the roots of the central incisors which also get displaced mesially. A resultant distal divergence of the crowns of the incisors occurs leading to creation of diastema in the incisor region. Broadbent named this as the ugly duckling stage as children tend to look ugly during this phase of development. Parents are often apprehensive during this stage and consult the dentist. This condition usually corrects by itself when canines erupt as the pressure is transferred from the roots to the crown of the incisors.

b. Eruption of the Second Permanent Molar

After the exchange of lateral teeth is completed and the dental arch up to the first molar is established, the second permanent molars begin to erupt. With the eruption of second permanent molar, the arch circumference may become shorter than that of the primary arch by utilization of the Leeway space.