

Development of occlusion:

Dr. Issam Aljorani (BDS, MSc. Ortho.)

Postnatal development of the dentition

When a child is born, mineralization of all the primary tooth crowns is well underway, with this process also beginning in the first permanent molars. The primary dentition will start to erupt in the first year of life and will be established by the end of the third. The permanent dentition is heralded by eruption of the first molars at around 6 years of age and is completed in most cases, by the appearance of the third molars in the late teenage years.

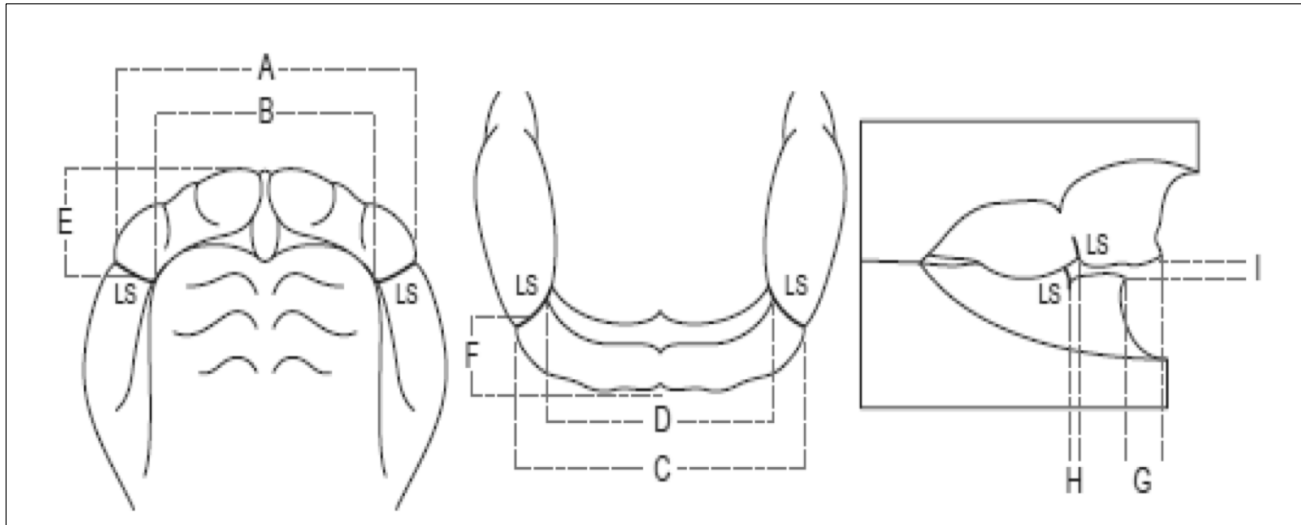
The jaws at birth

At birth, the maxillary dental arch is characteristically horseshoe-shaped whereas the mandibular arch assumes a wider U-shape. The mucous membrane of both the maxilla and mandible is thickened in the newborn infant to produce gum pads, which cover the alveolar processes containing the developing primary teeth.



Usually the upper jaw overlaps the lower jaw in antero-posterior and in transverse direction, in other words: the upper jaw is wider than the lower jaw and at the same time, the lower jaw is in a retrognathic position in relation to the upper. On the upper jaw, we can see the lateral sulcus, which expresses to the distal margin of the upper deciduous canine

and the gum pads, which is separated from the masticatory mucosa by a long and continuous groove called gingival groove. The upper lip at this stage is usually short, and the anterior oral seal of the mouth occurs due to the contact between the lower lip and the tongue. At this age the anterior gum pads are averted anteriorly and when the child closes his mouth there is a space between the anterior gum pads and the only part that is in contact are the future growing E(s) (Es region).



The maxillary (left) and mandibular (middle) gum pads in isolation and occlusion (right). Note the prominent lateral sulci (LS) present in both arches. A, C, external arch width; B, D, internal arch width; E, F, anterior arch length; G, overjet; H, anteroposterior relationship; I, overbite.

The elevations of the Es cannot be seen clearly, until the age of 5 months, the anterior opening of the mouth will facilitate the feeding process without discomfort to the mother, at this age usually the labial frenum is attached to the incisive papillary region and after the eruption of the deciduous it will migrate in upward direction and gives the incisive papillary attachment this is due to alveolar bone formation in association with the development of the deciduous teeth.

Occasionally a child is born with teeth already present or that undergo precocious eruption within the oral cavity

- Natal teeth are present at birth.
- Neonatal teeth erupt within the first month of life; and
- Pre-erupted teeth appear within the second and third months of life.

Natal and neonatal teeth occur in around 1: 3000 children and are usually mandibular primary incisors, although rarely they can be supernumerary teeth. They are often poorly developed, mobile and can cause ulceration of the mouth and nipple during suckling. If these teeth give rise to problems, they should be removed.

Deciduous Dentition

Usually the deciduous teeth begin to erupt at the sixth months of age until 2.5 – 3 years of age. (All the deciduous teeth will be erupted, completely, at the age of third years), and can be a source of some malaise for the child. Teething is associated with tender swollen gums, irritability, finger sucking, drooling and nocturnal crying. It is generally self-limiting but can be relieved by allowing the child to chew on clean, hard, cool objects and the provision of appropriate analgesia, either in the form of an elixir or lignocaine based teething gel. Occasionally, primary tooth eruption is preceded by the appearance of an eruption cyst, a small bluish-type swelling, which overlies the erupting tooth. These generally disappear, but can be excised if they persist.

Eruption sequence of deciduous dentition:

This includes:

Lower (As) at 6th month,
Lower (Bs) at 7th month,
Upper (As) at 8th month,
Upper (Bs) at 9th month,
Lower (Ds) at 12th month,
Upper (Ds) at 14th month,
Lower (Cs) at 16th month, upper (Cs) at 18th month,
Lower (Es) at 20th month,
Then finally, upper (Es) at 24th month.

The first sign of the formation of the deciduous teeth is at the age of 4-6 months IUL, and their roots will be completely formed after 12 – 18 months after their eruption. When these

teeth erupt in the mouth, they will erupt in a vertical direction i.e. the upper long axes of the centrals coincide with the long axis of the lower incisors, and usually there is slightly increase in the over-jet.

These teeth usually present in their crept in a rotated manner, this is to occupy a less space in the child's mouth; so that, when they erupt, they will erupted in a spaced conditions, and these spaces usually present at the mesial aspect of the upper canine and the distal aspect of the lower canine.

These spaces are termed as primary spaces or anthropoid spaces, since it looks like the spaces that are present between the teeth of the higher Apes.

Such spaces also present mesial to the Ds, these spaces that are anterior to the Ds, try to close in a way that: the distal surface of the D (upper and lower) will be located on the same terminal plane and usually the lower D is larger in mesiodistal dimension than the upper D. The Es when erupt, they erupt in the same terminal plane (flush terminal).

In summery the complete primary dentition is classically associated with a number of characteristic features:

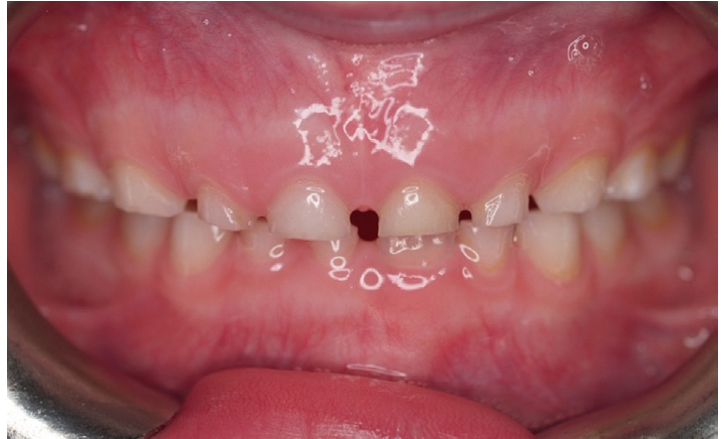
- The arches are semi-circular in shape;
- The incisors are spaced, upright and associated with a positive overjet and overbite;
- Primate or anthropoid spaces are present, mesial to the maxillary primary canines and distal to the mandibular canines;
- The molar and canine relationship is class I; and
- The distal edges of the second primary molars are flush in the vertical plane.



Changes in spaces:

The spaces of the deciduous teeth try to increase with age due to the growth of the jaws in: anteroposterior, transverse and vertical direction, and due to: attrition; since the shape of the deciduous teeth is triangular and these teeth will be subjected to a great amount of attrition due to wear at the incisal edges; so, the spaces will be increased, especially anteriorly due to the attrition. This attrition will occur at the incisal edges and the proximal surfaces since the deciduous teeth mostly converted into edge to edge relationship at a later stage. At the age of 5.5 - 6 years the permanent teeth begun to erupt, and these teeth contains an eruptive cyst, and this is filled with fluid, this fluid will exert a pressure on the roots of the deciduous teeth causing their resorption with the aid of special enzyme which is produced at this stage of age.

The roots resorption of the deciduous teeth means decrease in the root length and since the occlusal forces at the age of 5-6 years are more than those of 3 years; so, these occlusal forces together with the root resorption will increase the mobility of the deciduous teeth and if the deciduous teeth in closed case (without spacing), this will produce attrition of the proximal surfaces due to friction produced by movement during mastication, as the mobility progress the spaces will be increased and this will facilitate the process of normal shedding of the incisors.



Usually, the permanent teeth when erupt ,they are located at the palatal or lingual aspect of the deciduous incisors, causing their resorption during eruption, but sometimes, the permanent teeth could be deflected from the roots of incisors; therefore, this process will not happen in the normal way, and the permanent erupt ,while the deciduous is stay in its space.

Permanent Teeth:

Variations in the eruption sequence of the permanent teeth are common, but as a rule, the mandibular teeth erupt prior to the maxillary. Permanent teeth begin their eruption once crown formation is completed, taking between 2 and 5 years to reach the alveolar crest and a further 1 to 2 years to reach occlusion. Root development is usually completed within 2 years of eruption.

Permanent teeth replace the deciduous teeth (A, B, C, D and E) by (1, 2, 3, 4 and 5); while, the molars (6, 7 and 8) are developed in a separate entity.

The *sequence and timing of emergence* of permanent teeth include:

1-First stage for permanent teeth emergence (development).

Lower 6 ⇒ at 6 years

Upper 6 ⇒ at 6 – 6.2 years

Lower 1 ⇒ at 6.5 years

Upper 1 & lower 2 ⇒ at 7.5 years

Upper 2 ⇒ at 8.5 years.

There is a silent period extend from 8.5 years of age to 10 years of age, this period is called (Lull period). In this stage: there is no teeth emergence (development) or exfoliation, but there is changes in the occlusion including the anteroposterior and vertical dimension.

2-Second stage of permanent teeth emergence:

Upper 4 & lower 3 ⇒ at 10 years

Lower 4 ⇒ at 10.5 years

Upper & lower 5 ⇒ at 11 years

Upper 3 ⇒ at 11.5 years

Upper & lower 7 ⇒ at 12 years

3-Third stage of permanent teeth emergence:

It is the stage of emergence of the third molars at the age between 18 to 24 years of age (some time above 25).

The sequence of teeth emergence:-

For the upper permanent teeth is (61245 3 7) \Rightarrow 100%. While the sequence of emergence of the lower permanent teeth is either: (6123457) \Rightarrow in 50% of cases, or: (6124357).

In the lower arch, the first premolar may erupt after the emergence of the lower canine or before it.

Normal emergence at the first stage of permanent teeth

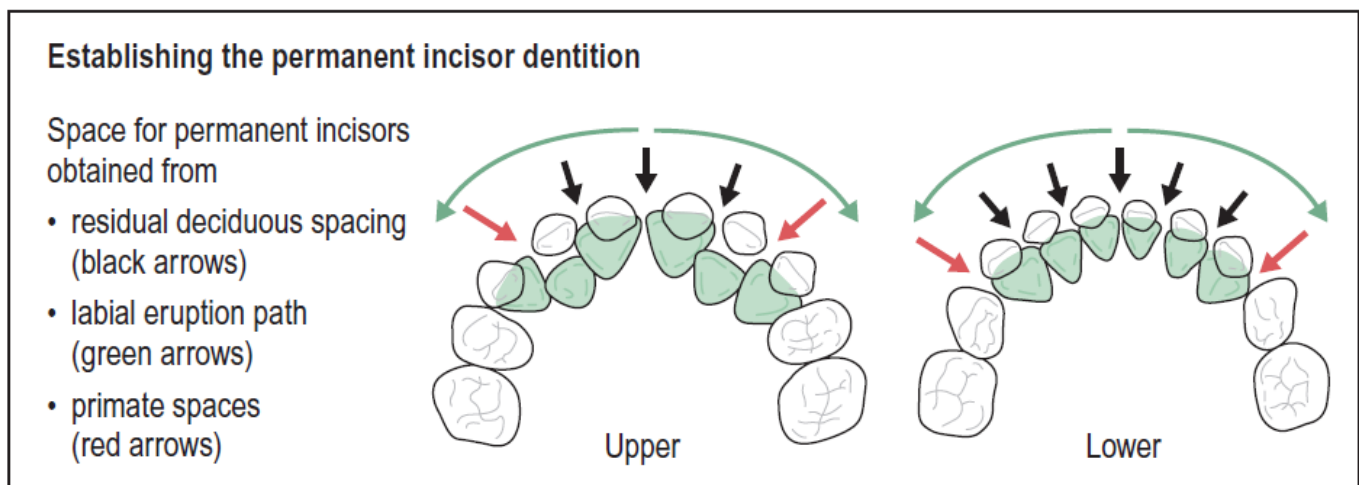
The permanent central incisors will replace the deciduous central incisors, and the deciduous lateral incisors also will be replaced by the permanent lateral incisors. Now: the question is that: How the central incisors erupt in a normal condition in spite of their mesiodistal collective width is larger than that of the deciduous teeth?

This normal emergence will occur due to these reasons:

- 1- Utilization of all the spaces that is present between the deciduous teeth.
- 2- Due to proclination of the incisors during the eruption.
- 3- Due to the secondary spaces.
- 4- Transverse increase in the intercanine arch width.

About the first reason: usually there is a space mesial to the upper deciduous canine and distal to the lower deciduous canine and this space will be utilized by the incisors during their eruption. However, the space distal to the lower canine can be utilized by the buccal segment teeth during (the early mesial shift). About the second reason: the incisors erupt in a proclined situation and this will increase the available arch length present for the permanent incisors, and this proclination is mainly due to the increase in activity of the tongue at this period (8.5 years) due to the increased amount of the growth stimulation hormone at this period.

About the third reason: during the eruption of the lower incisor, the lower deciduous canine will be pushed in a distal and buccal direction due to the fact that: the collective mesiodistal width of the permanent incisors is more than the collective mesiodistal width of the deciduous incisors, and since there is a contact between the lower deciduous canine and the upper canine during the lateral extrusion and during the protrusion \Rightarrow so, the upper deciduous canine will be pushed in a lateral and distal direction and this will produce an additional spaces named as: **secondary spaces**, which will be utilized by the permanent incisors. This will permit the permanent incisors of the adult face which is present in a small child face to erupt in a normal way.



Variations (changes) exist during the eruption of incisors:

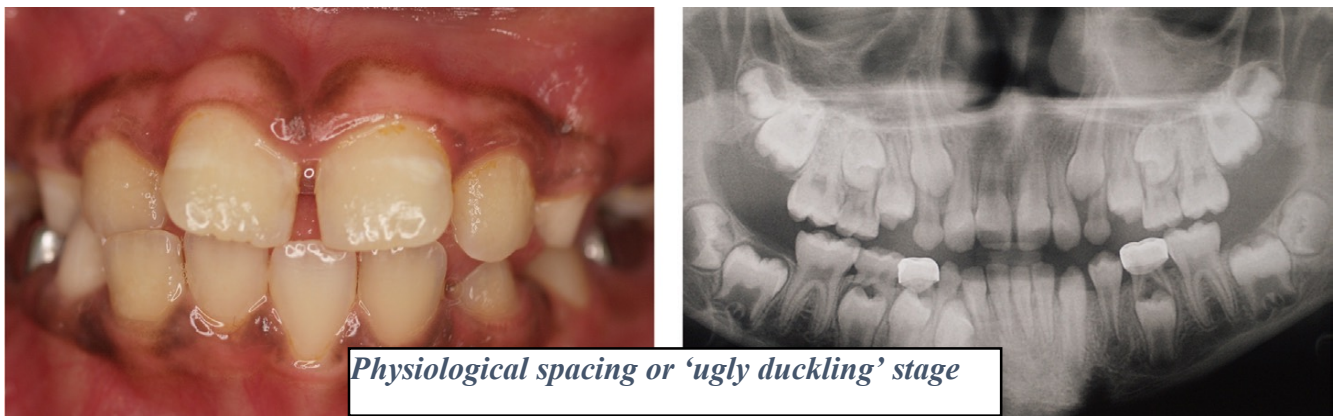
The permanent central incisors and the lateral incisors erupt palatal to the deciduous incisors in the upper arch, and lingual to the deciduous incisors in the lower arch, and in their development (eruption), they should be guided into a downward and forward direction to contact the roots of the deciduous incisors causing their resorption. Additionally the permanent incisors located in their crypts in a (zigzag) fashion, and the lateral usually trapped by the central incisors.

Anyhow, if the incisors deflected from this path of eruption, \Rightarrow they will erupt lingual and/or palatal to the deciduous incisors and this will lead to “anterior cross bite”, but if

there is normal path of eruption, they will erupt in a normal way. Since the lateral incisor situated lingual or palatal to the central incisor, therefore they may be influenced by: malocclusion more than the centrals; because they erupt later and if there is no available space in the dental arch \Rightarrow the centrals will occupy the available space, and the remnant of the space may be not enough for the eruption of the lateral incisors. Therefore, they will be erupted in a rotated or cross bite condition. In the normal way: the lateral escapes from the central incisors at the time the centrals begun to erupt.

A transient anterior open bite can be associated with eruption of the incisors as they approach the occlusal plane and this invariably improves with time.

The maxillary central incisors can also be quite distally inclined when they first erupt, which produces a midline diastema between them. This physiological spacing or 'ugly duckling' stage is thought to be due to the combined effect of the maxillary incisor apices being initially quite close together in the anterior maxilla as the incisors erupt and lateral pressure from the erupting maxillary lateral incisors and canines. As these teeth erupt, this pressure is transferred from the apical region of the maxillary incisors more coronally, improving their inclination and usually closing the diastema.



Physiological spacing or 'ugly duckling' stage

The first molars eruption:

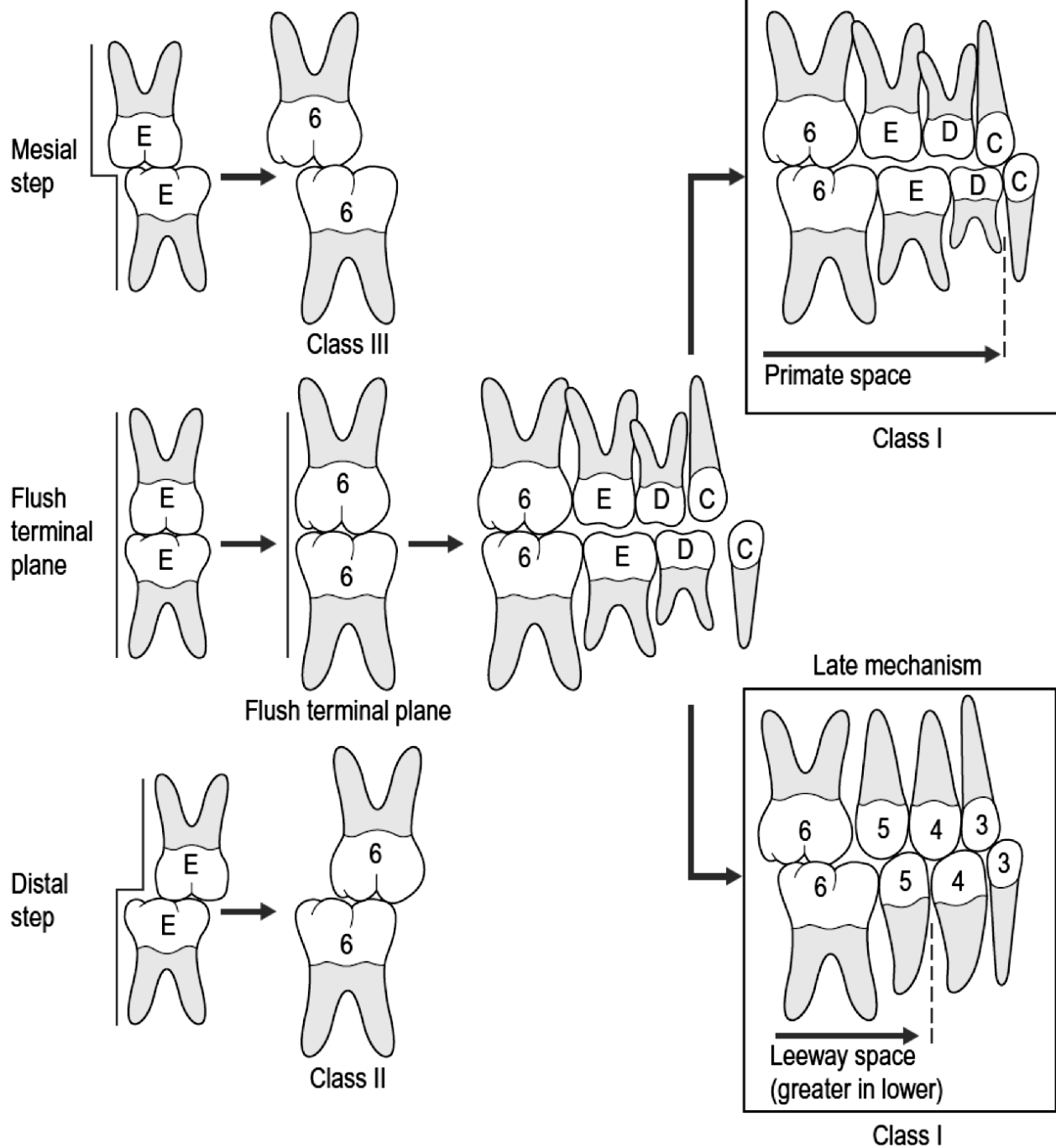
These teeth erupt as the upper and lower Es are still present. If the Es present with an cusp to cusp relationship (flush terminal plane) \Rightarrow the 6s will erupt cusp to cusp relationship and this is the normal situation for eruption of 6s which will developed as a CI I in 76% of cases, CI III in 14% and CI II in 10%.

The initial occlusal relationship of the first permanent molars is directly influenced by the primary second molar position. If these teeth are flush in the terminal plane then the first permanent molars assume a cusp-to-cusp relationship when they erupt. In order to establish a class I molar relationship, some mesial movement of the mandibular first permanent molar will be required. This is achieved by two possible mechanisms:

- **Early mesial shift**, where the lower primate space (distal to the mandibular canine and therefore adjacent to the primary molar occlusion) is closed by forwards movement of the mandibular molar as the first permanent molar erupts; and
- **Late mesial shift**, where the mandibular first molar only moves in a mesial direction after loss of the second primary molar; because the mesiodistal length of the mandibular second primary molar crown is greater than the maxillary, the loss of these teeth results in greater mesial movement of the mandibular first molar.

Occasionally, a mesial step occlusion of the primary molars might have been established prior to eruption of the permanent molars; in these cases they will tend to erupt directly into a class III occlusal relationship. Alternatively, there may be a distal step occlusion, in which case the first molars will erupt into a class II relationship. However, it should be remembered that all of these relationships affecting the primary molars and therefore establishment of the molar occlusion will be significantly influenced by the relative amounts of forwards maxillary and mandibular growth that occur during this time.

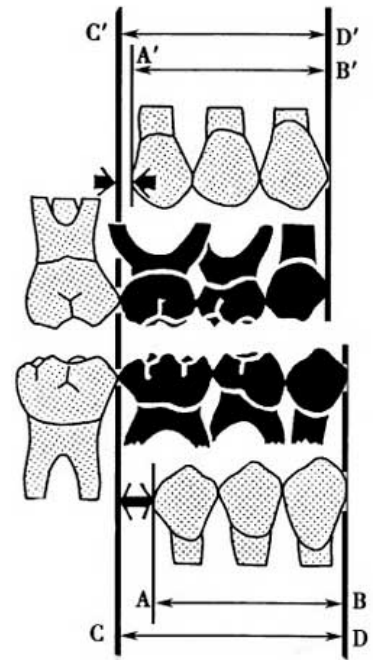
Establishing the permanent molar dentition



The second stage of development

In the second stage of permanent teeth development: the C, D and E are replaced by 3, 4, and 5. In contrast to the incisor dentition, the combined mesiodistal length of the primary canine and molar teeth is greater than that of the permanent canine and premolars, an excess known as the **leeway space**. In the maxilla, this is approximately 1.5 mm per quadrant, whereas in the mandible it is closer to 2.5 mm, because of the increased size of the lower second primary molar.

This difference in space is very important for the development of normal occlusion during **late mesial shift**.



The variation exist in this period includes:

Impaction of lower 5(s) due to lack of space for it due to or since it is the latter tooth which is erupted in the lower jaw mesial to the lower seven. While in the upper jaw, the lack of space will influence the canine eruption, since the latter tooth erupts prior to the upper seven in maxilla.

For the lower second premolar: it may be erupted in the lingual direction or it may be impacted under the first permanent molar; while, for the upper canine: it could be erupted to the buccal direction or it could be impacted if it is directed palatals. Also in this period the reduction of the arch size “lack of space” is seen if one of these reasons is/are occur. In Iraq, the malposed canine can be seen in female more than in male and if it is erupted into a buccal direction it takes a mesiobuccal angulation and a buccal inclination. But, if it is directed palatally then, it will be mostly impacted because the masticatory mucosa cannot be pierced by the canine due to the presence of high amount of collagen fibers. The upper canine is influenced by the problem of malocclusion in a great amount in comparison to the other teeth due to its long path of eruption “ development” since its early development occur under the orbit.



Crowding of the maxillary canine (left panel) and mandibular second premolar (right panel). The UR3 is buccally crowded due to timing of eruption; the LL5 is crowded due to early loss of the LLE.

For the canine to developed normally, it should firstly directed mesially until it touches the apical part of the root of the lateral incisors, then it directed into a downward direction, and lateral direction till reaches the occlusal level. If the root of the lateral incisor is abnormal or the lateral is missed, then the canine will loss its guidance plane of eruption and it will be erupted in any direction or in any situation; therefore it will be subjected to more problem of malocclusion due to its tortuous path of eruption and due to the lack of space available for it, and due to its dependence on the presence or absence of the permanent lateral incisors.

In this stage, there is a reduction in arch length as a result of;

- ❖ Premature loss of primary second molars.
- ❖ Ectopic eruption of the permanent maxillary first molar.
- ❖ Reduction in arch length as a result of caries.

About the eruption of Sevens (upper & lower):

They erupt at the age of 12 years old, and they occupy the same position of the 6s and usually the upper seven developed below the maxillary antrum and situated in a high level in the maxillary tuberosity and it takes a long path of eruption, but it is less than the canine. In comparison with canine's path of eruption is twice as long as the second molar's path of eruption. Therefore, it is subjected '7' to a less amount of crowding in comparison with

the canine. Usually the upper sevens when erupt, they directed distally, occlusally and buccally, but for the lower sevens, they have a short path of eruption in spite of they developed at the anterior border of the ramus, but they are directed mesially and occlusally. Therefore, they are “lower 7s” subjected to a less amount of crowding in comparison with the upper sevens.

The upper 7s in their eruption try to move in a faster rate to compensate for the downward and backward growth of the maxilla at the pterygomaxillary fissure = maxillary tuberosity. For the lower sevens: the ramus will increase in its width by bone resorption at the anterior part, and bone deposition at the posterior part. I.e. posterior border. This will provide a space for the eruption of the lower sevens.

The malocclusion of the sevens is very rare and the impaction of the upper sevens is very rare, while the lower sevens may be impacted in some instances.

Third stage of development:

The eight try to erupt between the ages of 18- 24 years of age. The path of eruption of the 8s is nearly similar to the path of eruption of the 7s. The upper 8s developed at the posteroinferior position of the maxillary tuberosity, so, these teeth are subjected to a high amount of crowding in comparison with the 6s or 7s ⇒ due to the lack of space available for them. The lower third molar may be subjected to impaction due to lack of space. These teeth may be absent congenitally due to etiological reasons since the human jaws tend to be reduced in size while, the size of teeth are remaining as it is.

Occlusal changes in the permanent dentition

The dentition does not remain static throughout life. Crowding of the mandibular incisors is one of the most common problems encountered in the permanent dentition and lower incisor alignment is one of the most likely things to relapse after orthodontic treatment. Studies of untreated subjects followed from the mixed dentition into adulthood have shown a tendency for the width and length of the mandibular arch to decrease and for crowding of the anterior teeth to increase . Primary crowding refers to a discrepancy of

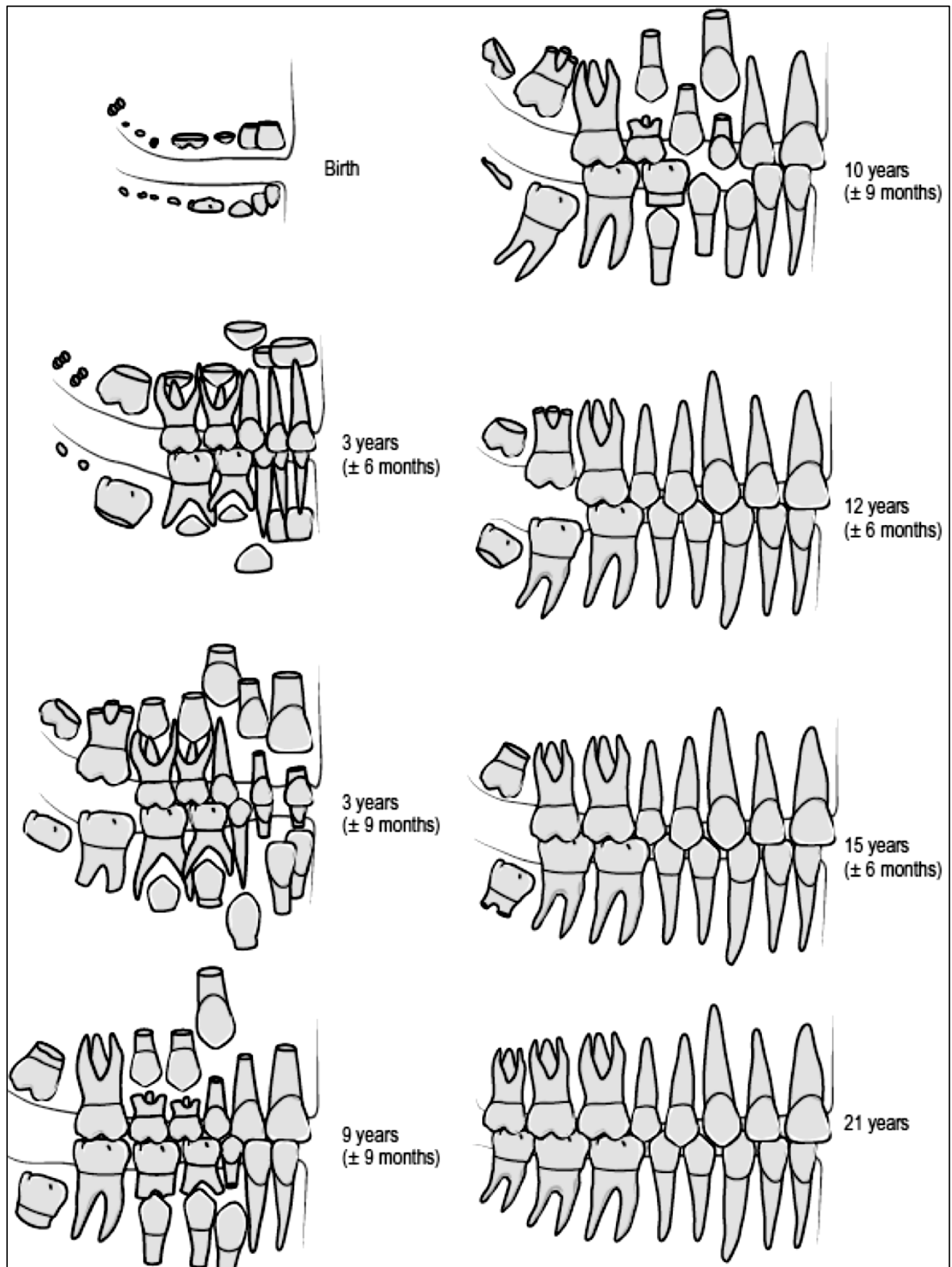
tooth dimension and jaw size, mainly determined genetically. Secondary crowding is caused by environmental factors, including local space conditions in the dental arches and the position and function of the tongue, the lips and the buccal musculature. Tertiary crowding occurs during adolescence and post-adolescence with a predilection for the lower labial segment. Factors contributing to late lower incisor crowding may include:

- Mandibular growth rotations;
- Physiologic mesial drift;
- Soft tissue maturation;
- Degenerative periodontal changes allowing teeth to drift under light pressures;
- Change in diet and lack of interproximal wear;
- Tooth size and shape;
- Tooth loss and drifting leading to changes in occlusal function; and
- Mandibular third molars – presence and position.

In reality, all of these factors may contribute to the development of late lower incisor crowding but the contribution of developing third molars is regarded as being minimal as crowding can develop even in the absence of their development. The prophylactic removal of developing third molars is not recommended to prevent late lower incisor crowding.



Late lower incisor crowding in an untreated mandibular arch.



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Dr.Issam M. Abdullah Aljorani

BDS, MSc. Ortho.

asd.issam@gmail.com

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