THE MIXED DENTITION STAGE

The mixed dentition stage starts with the eruption of the first permanent tooth (6s), and is normally end at the time of last primary tooth is shed. During this stage significant change in the dentition has occurred as a result of shedding 20 primary teeth and eruption of their permanent successors.
The deciduous teeth (A,B,C,D and E) is replaced by their permanent successors (1,2,3,4 and 5) respectively; while the first permanent molars (6s) are erupted in a separate entity.

During the mixed dentition, both deciduous and permanent teeth are present. It begins around 6 years of age with the eruption of the first permanent molars. It divided into 3 phases:
1. First transitional period
2. Inter-transitional period
3. Second transitional period

There three phases for the eruption of permanent teeth:
• Eruption of 1st molars and incisors;
• Eruption of premolars, canines and second molars; and
• Eruption of 3rd molars.

Mixed dentition period

1. Early 1st transitional period (6-8 years)

Characterized by the **eruption of 1st permanent molar and exchange of deciduous incisors with permanent incisors**. The 1st permanent molar erupts at 6 year and its location depends on the deciduous molar relationship.
Variation in the eruption sequence of the permanent teeth are common, but as a general rule the mandibular teeth erupt prior to the maxillary. Permanent teeth start their eruption once crown formation is completed. Root development is usually completed within 2 years of eruption.

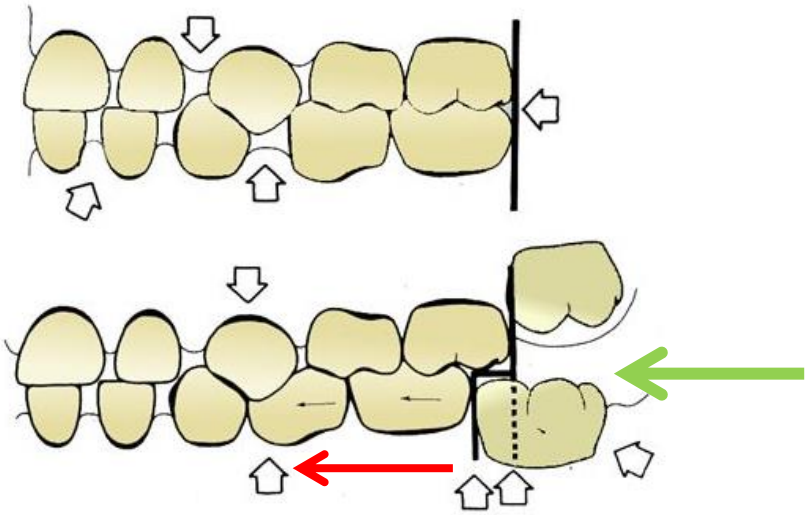
a) Eruption of first permanent molars:

The first permanent molars are guided by the distal surfaces of the second primary molars as they erupt into occlusion , erupt at the age of 6 years and usually the lower 6s erupt in advance , their eruption cause no exfoliation of any primary

tooth , they erupt distally to the 2nd primary molars .Thus, the terminal plane relationship of primary dentition largely determines the type of molar relationship in the permanent dentition, the permanent mandibular 1st molars initially emerge or erupt into **a cusp-to cusp** or **end on molar** relationship, the lower 1st permanent molar has to move 2-3 mm anteriorly in relation to the upper 1st permanent molar to transform the **end on molar** relationship to **class I molar** relation. This transformation occurs in two ways:

1- Early mesial shift: Early mesial shift of the lower permanent 1st molar occurs during early mixed dentition period by utilising the lower primate spaces (distal to the mandibular canine).

Eruption force of **1st permanent molar** is sufficient to push deciduous **1st and 2nd primary molar** forward (shift mesially) to close the primate space.



2- Late mesial shift: Late mesial shift of the lower permanent 1st molar occur by utilising of the **Leeway space**, where the mandibular 1st molar moves in a mesial direction after loss of the second deciduous molar. The mesiodistal width of the mandibular 2nd deciduous molar crown is greater than the maxillary second molar, therefore, greater mesial movement of the mandibular 1st molar than maxillary molar.

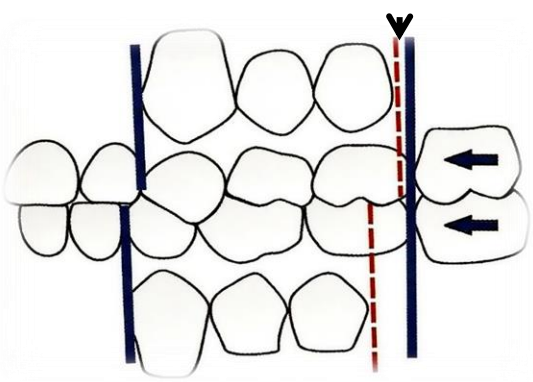
In cases when the primate space is absent, the permanent 1st molar shift drift mesially utilising the Leeway space. The eruption of 6s runs parallel in time with the eruption of the lower permanent central incisors.

C+D+E > 3+4+5

Leeway space in

Maxillary arch: 1.8 mm (0.9mm each side)

Mandibular arch: 3.4 mm (1.7 mm each side)

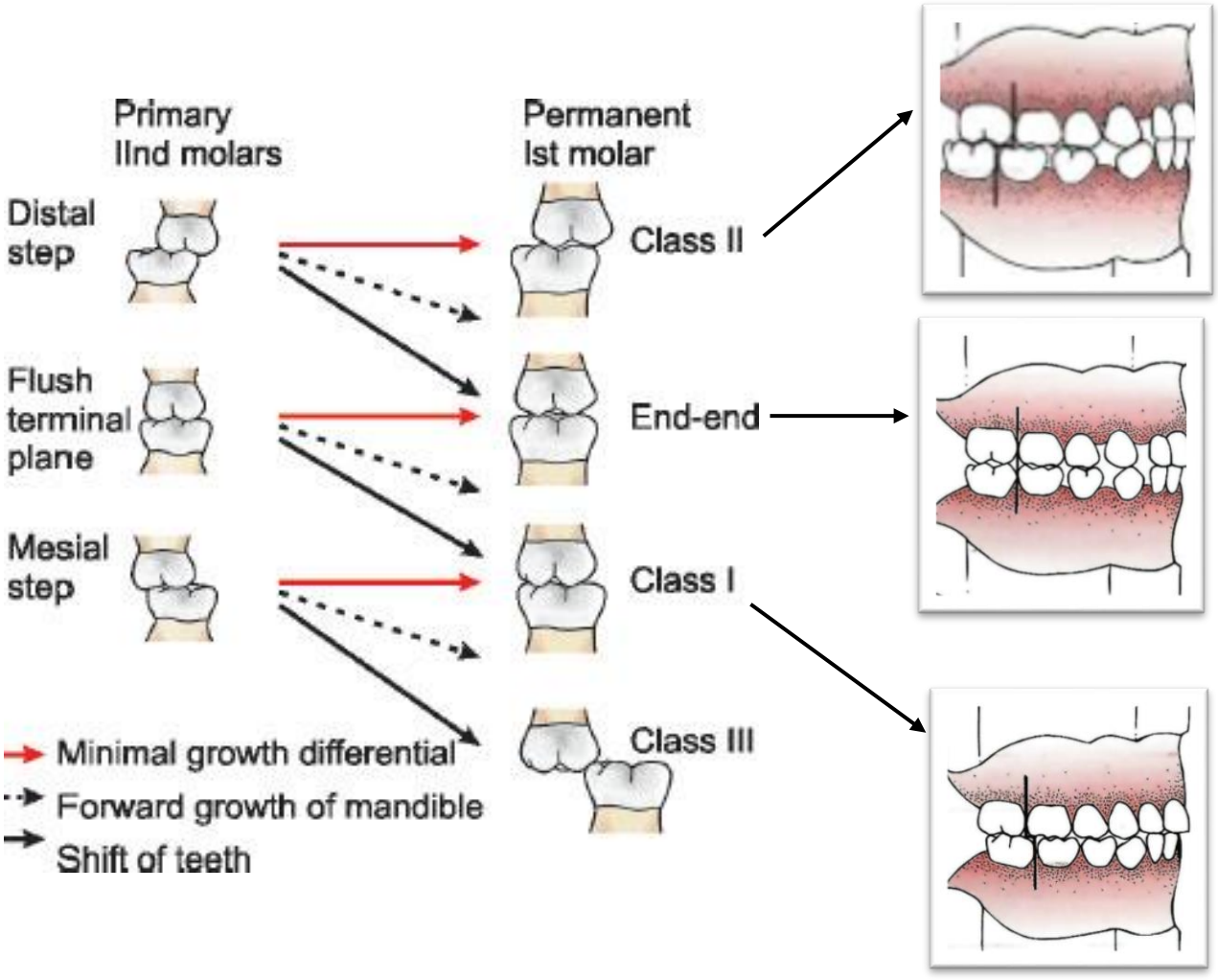


Early mesial shift of the 1st permanent molar; is the utilisation of ***primate*** spaces.
Late mesial shift of the 1st permanent molar; is the utilisation of ***Leeway*** spaces.

When the deciduous molar relationship is in flush terminal plane relationship the permanent first molars will end in Class I relationship after mesial drift of deciduous and permanent molars.

Occasionally, a mesial step occlusion of the deciduous 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.

Influence of terminal plane on the position of 1st permanent molar

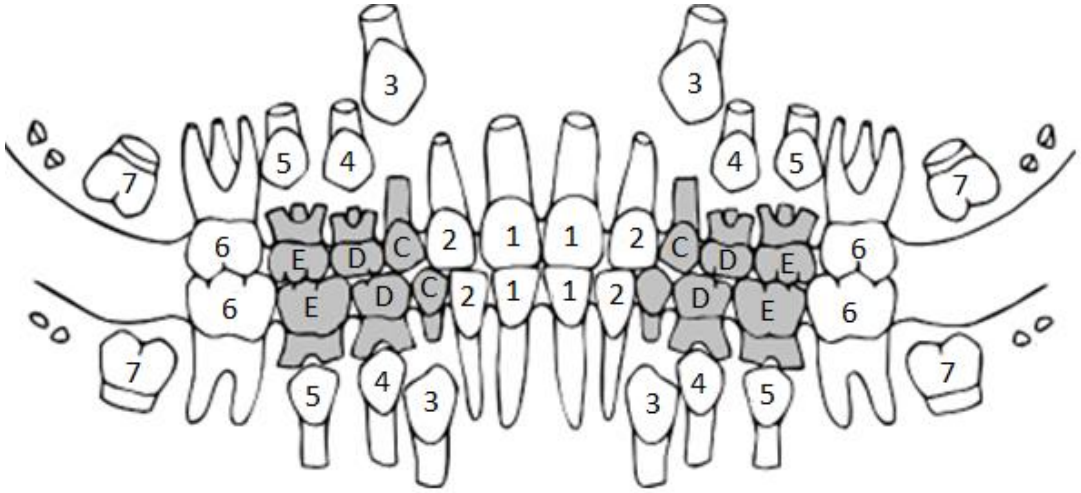


b) Eruption of permanent incisors:-

The position of the dental lamina of the permanent teeth is located lingually to all primary teeth. As a result the incisors develop in their crypt lingually and near the apex of the primary incisors. The permanent tooth resorbs the primary root and erupts slightly labial to the location of the primary tooth.

Within the next 6-12 months from first permanent molar eruption, i.e. at the age of 7 to 7.5 years the eruption of the upper central incisors (1s) occurs and at the same time the eruption of the permanent lower lateral incisors takes place.

Another interval of 6-12 months passes by to witness the eruption of the permanent upper lateral incisors (2s) i.e. by the age of 8 to 8.5 years. Normally by this age the 6s, 1s &2s are present intraorally side by side with the Cs, Ds, Es**.**



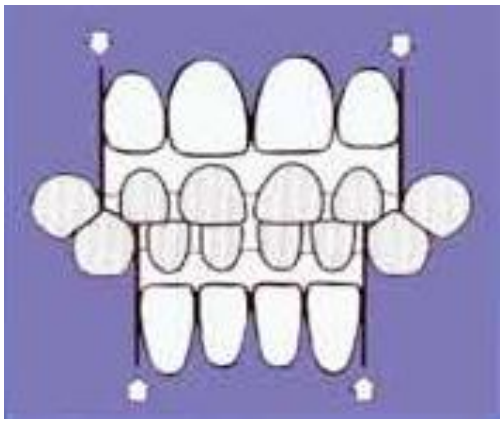
Mixed Dentition Period

Late Primary Dentition (3-6 yrs) ***1st Period of rest***	***Maxillary tooth number***	***6***	***1***	***2***	***Mixed Dentition (8.5-10 yrs)*** ***2nd Period of rest***
	Time of eruption (Years)	***6.1***	***7.4***	***8.4***	
	Mandible tooth number	***6***	***1***	***2***	
	Time of eruption (Years)	***5.8***	***6.2***	***7.6***	

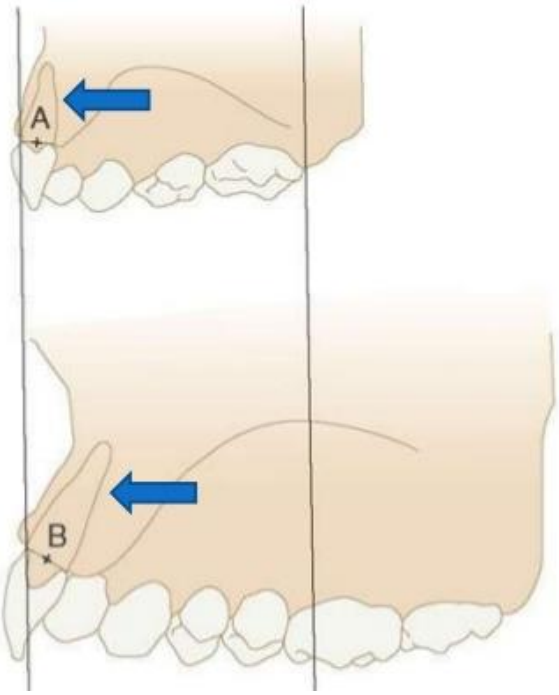
The sum of mesiodistal dimensions of crowns of permanent incisors is larger than their deciduous predecessors by approximately 6 mm in the mandible, and 7.6 mm in the maxilla. Therefore, more space is needed to accommodate the eruption of permanent incisors in an appropriate alignment.

The amount needed for the accommodation of the permanent incisors and the amount available for this is called Incisal liability. The incisal liability is overcomed by the following factors:

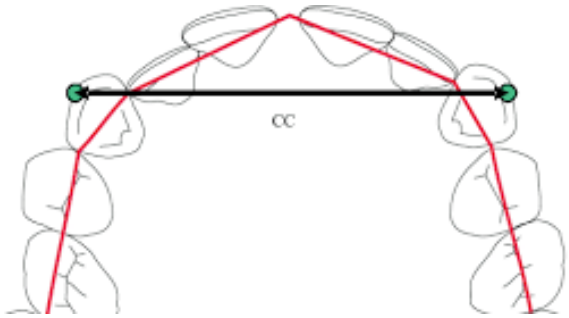
1*) Interdental (developmental) spacing* or called residual spacing present between the deciduous incisors; spaces present in primary dentition helps in the alignment of the permanent incisors.
2) Permanent incisors erupt labial to the primary incisors in which tend to increase the dental arch perimeter
3) Incisor inclination permanent incisors inclined labially, decreasing interincisal angle from about 150° in the deciduous dentition to 123° in the permanent dentition.
4) Transverse increase in the intercanine arch width: during the period of permanent incisor eruption, significant amount of increase in inter canine arch width occurs, which is about 3-4 mm
5) Deciduous canines being moved distally as the incisors erupt.



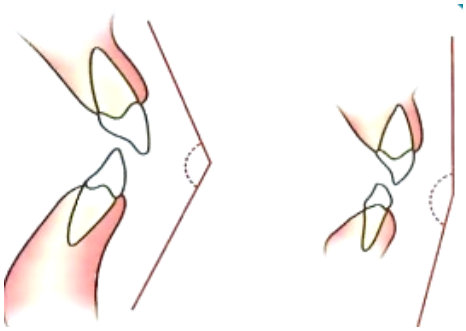
Incisal liability



A. upright primary incisor
B. Labial inclined permanent incisor



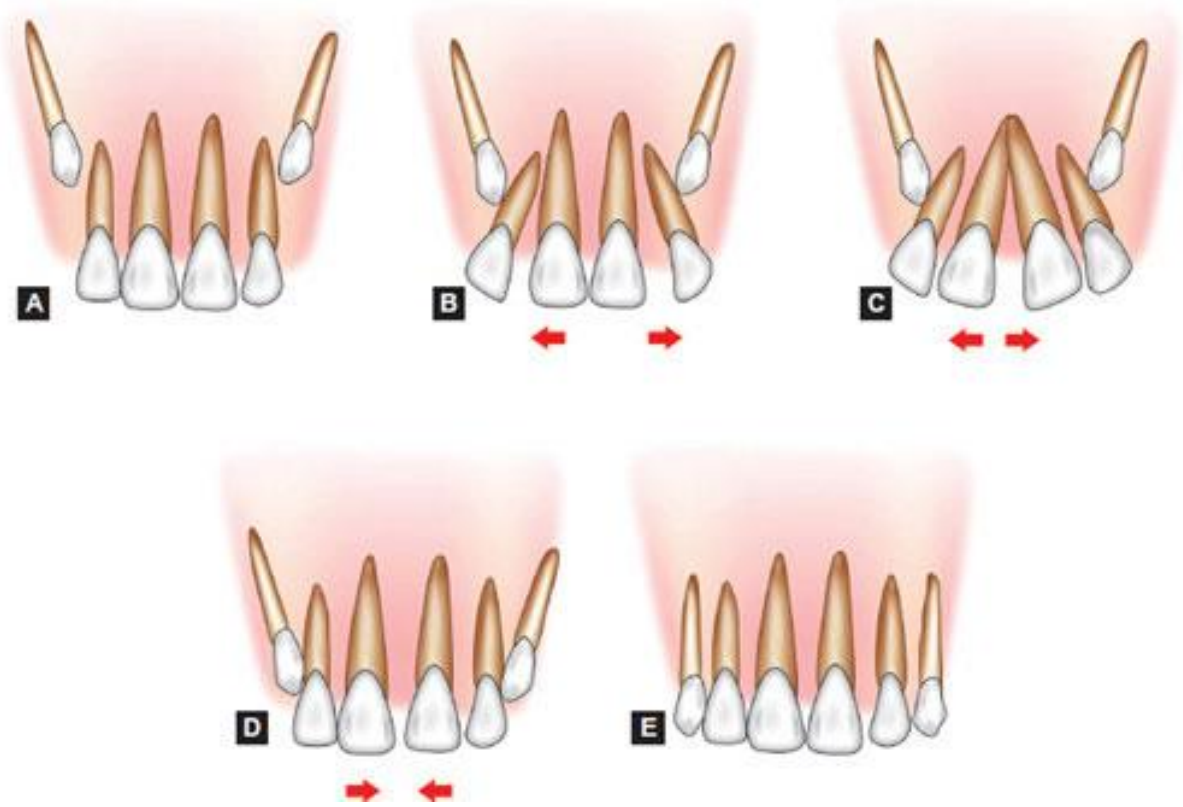
Intercanine width



Incisor inclination

During this period of the mixed dentition, a number of features are associated with the maxillary incisor teeth can be present prior to establishing the early permanent dentition:

a) **Transient anterior open bite**: 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.
b) Physiological spacing (**Ugly duckling stage**): It is a transient or self-correcting malocclusion with presence of midline diastema and flared maxillary upper incisors which seen between 8-9 years, during the eruption of permanent canine. After the upper lateral permanent incisors reach the occlusion , normally by the age of 8.5 years or even before , the crowns of the upper permanent canines are descending down from the floor of the orbit until it touches the distal & in same cases the distopalatal aspect of the roots of the lateral incisors near their apices , in a way a pushing force toward the midline are applied changing the inclination of the roots of the incisors mesially , thus the crowns of the four incisors will be inclined distally leaving spaces between them in a diverge shape i.e. more incisally than gingivally resembling the shape of the leg of the duck. Such spaces will be closed gradually when the eruption of the permanent canines change its path and run parallel to the roots of the lateral incisors, and by the time of eruption of permanent canines all these spaces will be encroached, in rare cases with large arches, small symmetrical spaces gingivoincisally may persist. Dentists should reassure the anxious parents and explain for being self-correcting malocclusion.



Ugly duckling stage (Broadbent's phenomenon)

From the age of **6** years to **8** years can be regarded as ***the first stage of eruption of permanent teeth.***

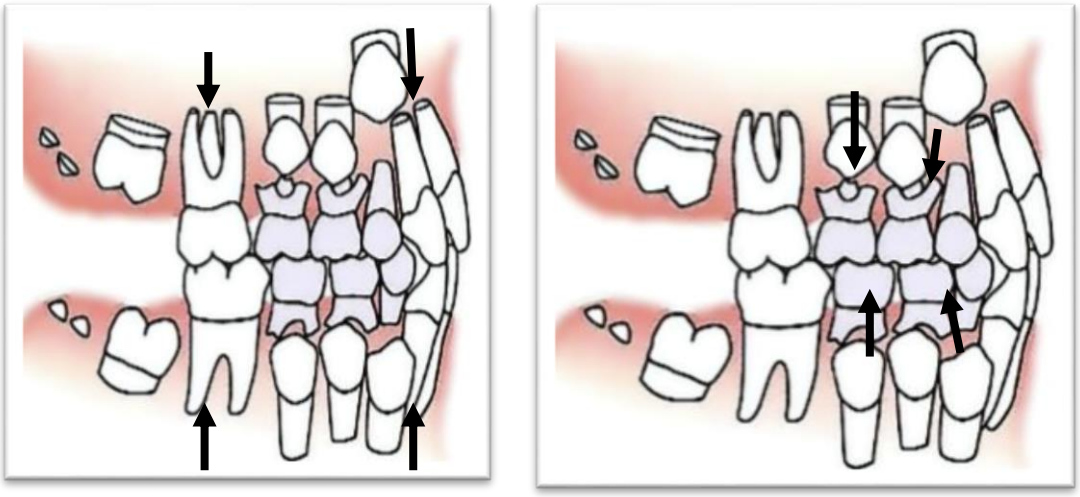
2. Inter-transitional period (8-10 years)

This period started when 1st permanent molar and permanent incisors are erupted completely. The dental arch consists of set of deciduous and permanent teeth. This period is relatively stable in which little changes in occlusion is seen.

There were no active eruptive process could be seen and ***considered a 2nd period of rest (period of Quiescence)***. This period is also called ***Lull period***, the teeth present are:

6 E D C 2 1	1 2 C D E 6
6 E D C 2 1	1 2 C D E

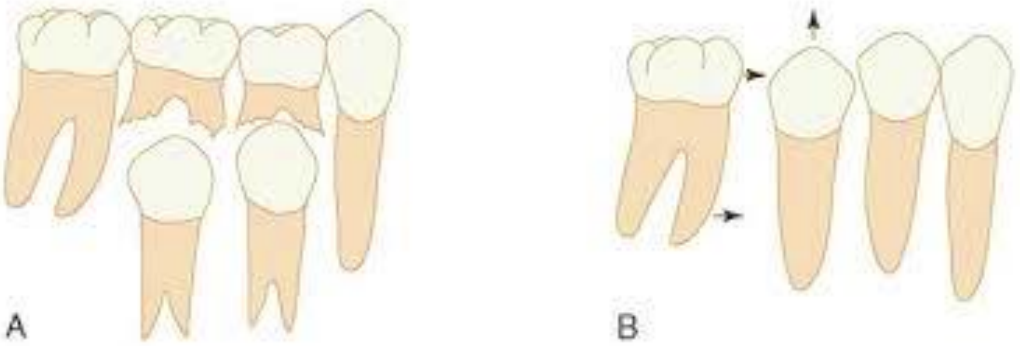
Root formation of emerged incisors, and molars continues, along with concomitant increase in alveolar process height. In addition, resorption of roots of deciduous canines and molars is also seen (Figure below).



At dental age 9, the maxillary lateral incisors have been in place for one year, and root formation of the incisors and 1st permanent molars is nearly complete.
Root development of the maxillary canine and all second premolars is just beginning while about one 1/3 of the root of the mandibular canine and all 1st premolars has been completed.
In this stage there is no teeth emergence or exfoliation, but there is changes in the occlusion including the antroposterior and vertical dimension.

3. 2nd transitional period

The second transitional period involves replacement of deciduous molars and canines by permanent premolars and canines respectively.
Most common eruption sequence is 4-5-3 in the maxilla and 3-4-5 in the mandible. Late shift of permanent molars occur in this period by utilising Leeway space to establish class I molar.
Eruption of these teeth normally occur between the ages of 10 and 12 years and as a general rule:
• In the mandible, the canine erupts ahead of the 1st premolar and this is followed by the 2nd premolar; and
• In the maxilla, the 1st premolars usually erupts first, followed by the 2nd premolar and then canine.



The ***second stage of the eruption of permanent teeth*** is characterised by the replacement of deciduous molars and canines by the premolars and permanent canines respectively and eruption of the four permanent second molars.

Mixed Dentition (8.5-10 yrs) ***2nd Period of rest***	***Maxillary tooth number***	***4***	***5***	***3***	***7***	***Permanent Dentition (12 yrs-3rd molar eruption)*** ***3nd Period of rest***
	Time of eruption (Years)	***10***	***10.9***	***11.3***	***12***	
	Mandible tooth number	***3***	***4***	***5***	***7***	
	Time of eruption (Years)	***10.3***	***10.4***	***11.3***	***11.6***	

At approximately 13 years of age all permanent teeth except the third molars are fully erupted, sequence of eruption of permanent dentition is more variable than that of the primary dentition. In addition, there are significant differences in the eruption sequences between the maxillary and mandibular arch.

The following sequence of eruption for both arches are dominant over the other sorts of sequence, especially in the 'buccal segment teeth" 3, 4, 5 nearly 60 - 75% of cases.

The sequence of eruption of maxillary and mandibular teeth is as follow:

6 1 2 4 5 3 7
6 1 2 3 4 5 7

Permanent Dentition Period

Characteristic features of occlusion in permanent dentition:
1- Coinciding midline.
2- Overlap: the maxillary teeth overlap the mandibular teeth, both in labial and buccal segments in centric occlusion.
3- intra-arch tooth contacts: with the exception of the maxillary third molars and mandibular central incisors, each permanent tooth occludes with two teeth from the opposite arch i.e. each permanent tooth has two antagonistic teeth.
4- Angulations: permanent teeth have buccolingual inclination and angulation, where as the primary teeth are generally vertically positioned in the alveolar bone.
5- Arch curvatures: The anteroposterior curvature exhibited by the mandibular arch is called the curve of Spee (1.3 mm). The corresponding curve in the maxillary arch is called the compensating curve. The buccolingual curvature from one side of the arch to the others is called the Wilson.

6- Incisor relationship: The vertical overlap between maxillary and mandibular incisors is called overbite and is about 2-4 mm and the horizontal overlap called the overjet is generally between 2-4 mm.
7- Molar relationship: In permanent dentition stage, the class I molar relationship is the idea relationship, in which the mesiobuccal cusp of the maxillary 1st molar is in the buccal groove of the mandibular 1st molar.

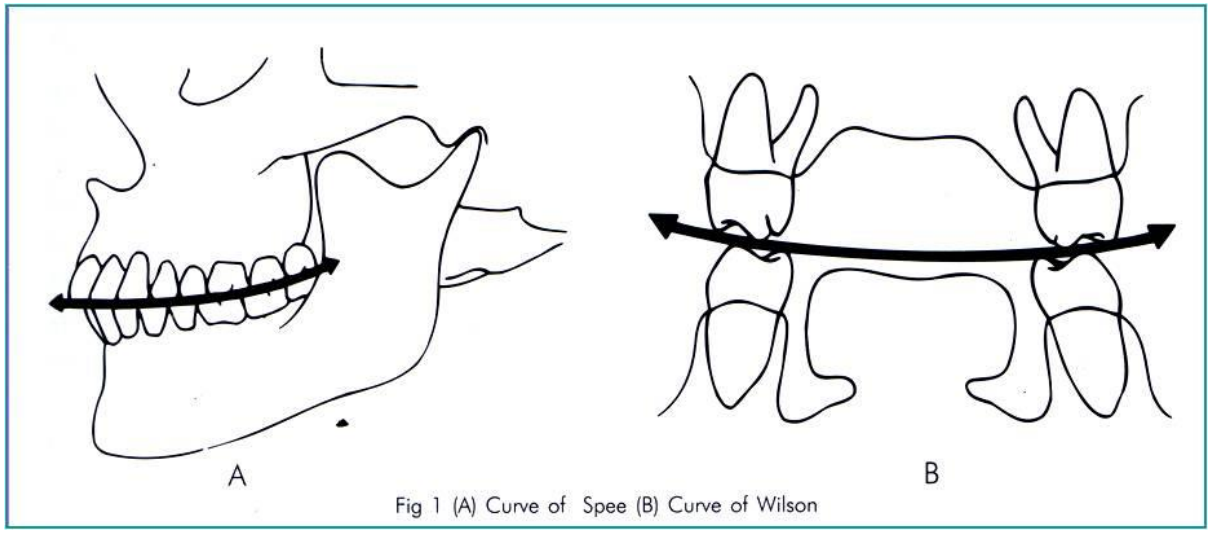


Fig 1 (A) Curve of Spee (B) Curve of Wilson

By the end of age 12 years, human teeth go with another period of rest until the age of 18-24 years where **the 3rd stage of eruption of permanent teeth take place** i.e. the eruption of the wisdom teeth "3rd permanent molars"; but the length of this period is variable, third molar may remain unerupted or fail to develop completely (congenital missing).
Permanent incisors develop lingual or palatal to the deciduous teeth and move labially as they erupt. Premolars develop below the diverging roots of deciduous molars
Controversy opinion on the effect of third molar eruption on the mesial drift of teeth and its subsequent effect on the position of the mandibular incisors. The eruption of 3rd molar has a role on mandibular arch crowding particularly during late teenage years. However, the aetiology of anterior teeth crowding is multifactorial. Therefore, prophylactic extraction of third molars is unlikely prevent or relief incisor crowding. At approximately 18-24 years of age thirty-two permanent teeth are fully erupted.

Permanent teeth development:

The completion of **root formation** takes place about 2-3 years after the eruption of teeth. The **Calcification time** of permanent tooth is as follow:

At birth the calcification of upper and lower 6s began.
While at age of **6 months** calcification of upper 1, 3 and lower 1, 2, 3 began.
At the age of **2 years** calcification of 2, 4s began.
At the age of **4 years** calcification of 5s, 7 began.
While the calcification of wisdom teeth began at the age between **8-14 years.**

Permanent maxillary teeth development and eruption time

MAXILLARY TEETH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
HARD TISSUE FORMATION	4 months	11 months	5 months	20 months	26 months	7 months intra-uterine	3 years	8 years
CROWN FORMATION	3.5 years	4.5 years	5 years	6.5 years	7 years	2.5-3 years	7 years	13 years
ERUPTION	7-8 years	8 years	11 years	10 years	10.5 years	6 years	12 years	18 years
ROOT FORMATION	9-10 years	10-11 years	12.5 years	12-13 years	12-14 years	9.5 years	13-15 years	21.5 years

Permanent mandibular teeth development and eruption time

MANDIBULAR TEETH	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
HARD TISSUE FORMATION	4 months	4 months	5 months	20 months	26 months	7 months intra-uterine	8 years	9 years
CROWN FORMATION	4.5 years	4.5 years	4.5 years	6.5 years	7 years	2.5 years	7 years	13 years
ERUPTION	6-7 years	7-8 years	10 years	10-11 years	11 years	6 years	12 years	18 years
ROOT FORMATION	8-9 years	9-10 years	11-13 years	11-13 years	12-14 years	8-10 years	14-15 years	20 years

FACTS ABOUT THE ERUPTION OF PERMANENT INCISORS

The permanent central incisors will replace the deciduous central incisors, and the deciduous lateral incisor also will replace by the permanent lateral incisors. 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?
Usually the primary incisors are spaced, such ***"primary spaces***" are going to be utilized by the bigger mesiodistal width of permanent incisors when they erupt, however the upper & lower permanent incisors tend to procline during their eruption which add another extra spaces for them. "Here the active tongue plays a role".
In certain cases if the space was not enough during the eruption of the lateral incisors, they have the ability to push the primary canines distally to gain extra spaces for their final aligned position; this is called the ***"secondary spaces"*** (i.e. there is an increase in intercanine width takes place during the eruption of the incisors).

Essential factors of smooth transition from primary to permanent dentition

1- Primary spaces between primary incisors.
2- Proclination of permanent incisors during eruption.
3- Development of secondary spaces (intercanine width).
The above 3 factors are essential for the eruption of the permanent incisors in an accepted alignment.
About 1st reason: there is a space mesial to the upper deciduous canine and distal to the lower 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 2nd 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 3rd 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 deciduous canine during the lateral extrusion and during the protrusion. so, the upper deciduous canine will be pushed in a lateral and distal direction and this will produce an additional space named as: ***secondary spaces***, which will be utilised by the permanent incisors.

VARIATIONS:

If the primary incisors are not spaced or they are crowded, we will expect that the permanent successors will be crowded, and commonly the lateral incisors 2s will be more affected, **WHY?**

A- If the deciduous incisors root is not resorbed normally; the permanent incisor may be deflected lingually.

B-The upper lateral incisors in their developmental position are overlapped by the central incisors. They escape as the central incisors erupt. If there is not sufficient growth in arch width they may be trapped in this palatal position i.e. if the arch is small the 2s may be seen rotated or even erupt lingually or palatally in **cross bite** position).

C-When the upper incisors erupt they are frequently distally inclined so that there is a median diastema. This is the **"ugly duckling stage"**.

ERUPTION OF THE PERMANENT MOLARS & BUCCAL SEGMENT TEETH:

Flush terminal plane is the predominant molar relationship in the primary molars**.** When the six years molars "1st maxillary and mandibular molars "erupt and particularly the lower molars , they will push the primary molars forward mesially to close the spaces distal to lower Cs ,this closure is termed ***early mesial shift***.

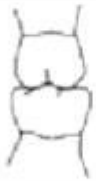
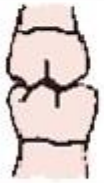
The total mesiodistal width of the primary molars &Cs are greater than the total mesiodistal width of their permanent successors the 5, 4 &3 in a difference called **Lee way** Space.

M.D width of C,D&E - MD width of 3,4 & 5 = Lee way space

The ***Leeway space*** is equal to **1.8 mm** (around ***0.9-1.2 mm*** in each quadrant) in the **upper arch** & about **3.4 mm** (around ***1.7- 2 mm*** in each quadrant) in the **lower arch**.

The Leeway space will be encroached when eruption of buccal segment teeth (3,4&5) occur, via the mesial movement of the 1st permanent &such event is called a ***late mesial shift***

The early and late mesial shifts are the main occlusal events that convert a flush terminal relation in the primary molars into the Class I molar relationship.

Primary Teeth Orientation	Most Probable Permanent Teeth Classification	Other Possible Permanent Teeth Classification
Mesial Step 	→ Class III 	Class I 
Flush Terminal Plane 	→ Class I 	End - End 
Distal Step 	→ Class II 	End - End