CONTENTS

INTRODUCTION

- Word Occlusion derived from the Latin word “**Occlusio**”.
- ***Mosby’s dental dictionary (Zwemer;1998)*** defines occlusion as “a static morphological tooth contact relationship”
- Acc. to ***Ash and Ramfjord*** , occlusion may be defined as “the contact relationship of the teeth in function or para function”.
- Acc. to ***Angle(early 1900)*** occlusion is “the normal relation of the occlusal inclined planes of the teeth when the jaws are closed .”
- Acc. to ***Gregory*** ,occlusion is the changing interrelationship of the opposing surfaces of the maxillary and mandibular teeth, which occurs during movements of the mandible and the terminal full contact of the maxillary and mandibular dental arches .

Why study occlusion??

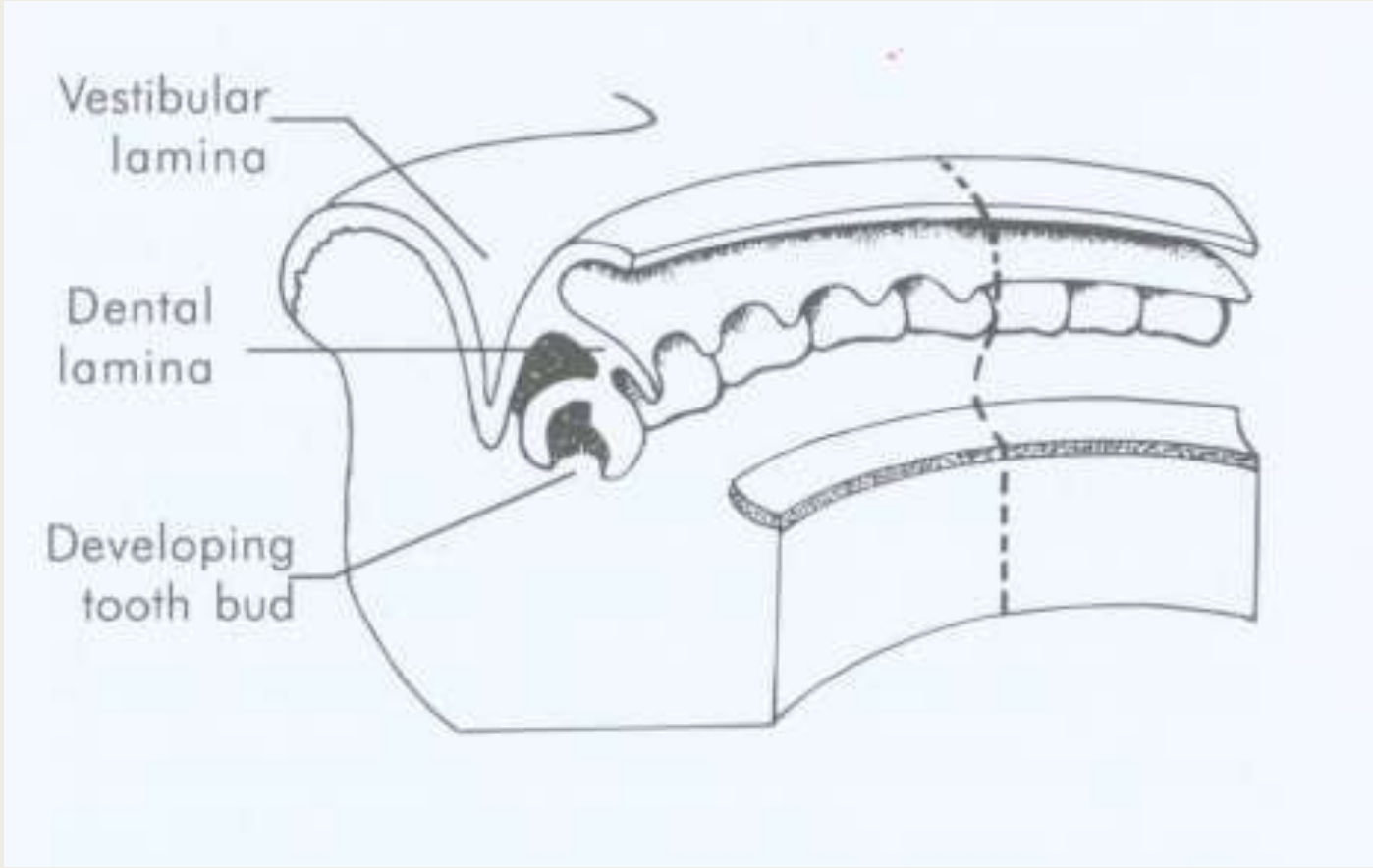
- Occlusion from the time of birth till the adult stage is a dynamic state.
- A knowledge of growth and development of arches helps to differentiate abnormal from normal relation of teeth and helps in diagnosis.
- Helps in treatment planning.
- Helps to undertake preventive or interceptive procedures.

Development of tooth.

- Starts around 5-6 week of Intrauterine Life.
- Starts developing from a band of epithelium that invades the underlying ectomesenchyme along each of the dental arches called Dental Lamina.
- Dental lamina serves as primordium for the ectodermal portion of the teeth.
- As the tooth develop, they loose their connection with the dental lamina and breaks up by mesenchymal invasion.

Tooth Development can be divided into 4 stages:

- BUD STAGE
- CAP STAGE
- BELL STAGE
- ADVANCED BELL STAGE.



BUD STAGE

- Dental lamina shows specific sites of increased mitotic activity which produces knob like tooth buds called ENAMEL ORGAN
- First Bud-Mandibular Anterior Region-7thWeek
- 8thWeek: All Maxillary and Mandibular primary tooth buds are present.
- Enamel Organ Enamel of Tooth
- Lack of initiation: Congenitally Missing tooth
- Abnormal Initiation : Supernumerary Tooth.

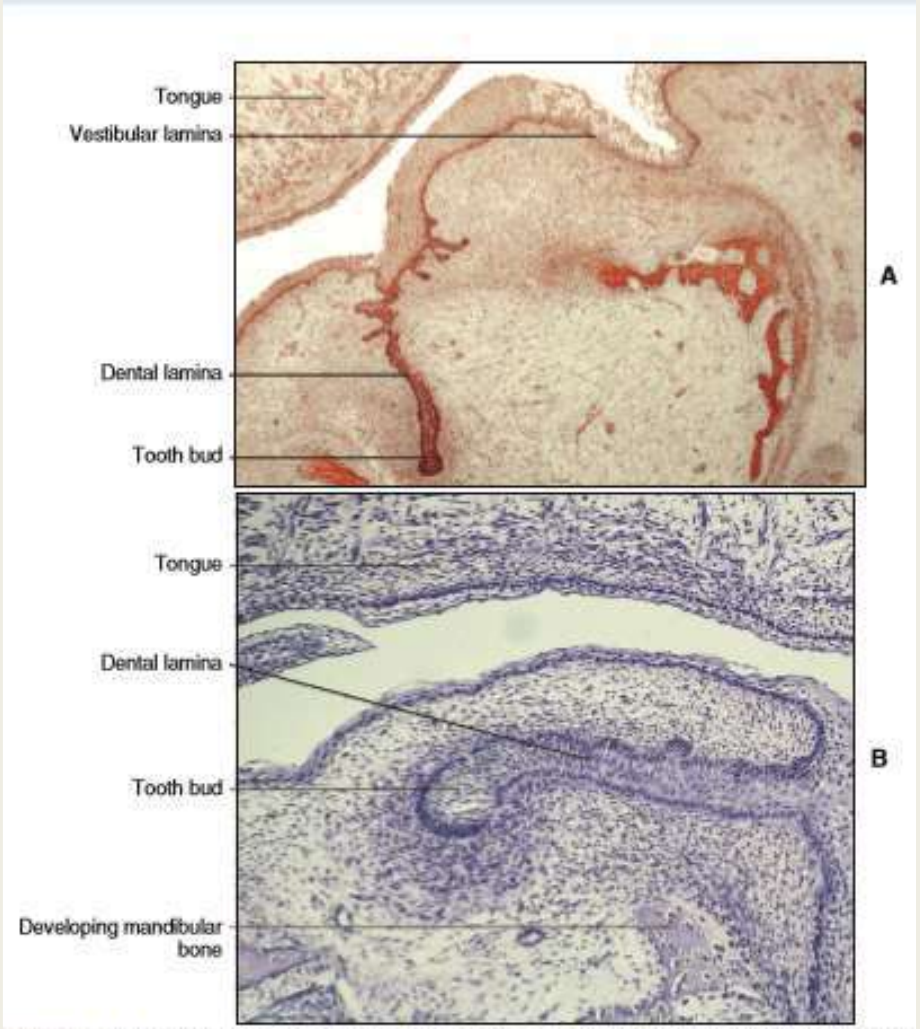


FIGURE 5-11 Bud stage of tooth development seen in coronal section (A) and sagittal section (B).

CAP STAGE

- As growth continues the tooth germ is seen leading to the formation of a cap shaped enamel organ characterized by a shallow invagination on the deep surface of the bud.
- At this stage enamel organ consist of 3 layers:
  - *Outer Enamel Epithelium (OEE)*
  - *Inner Enamel Epithelium (IEE)*
  - *Stellate Reticulum.*
- Differentiation of Odontoblast is seen
- Dental Papilla shows active budding of capillaries

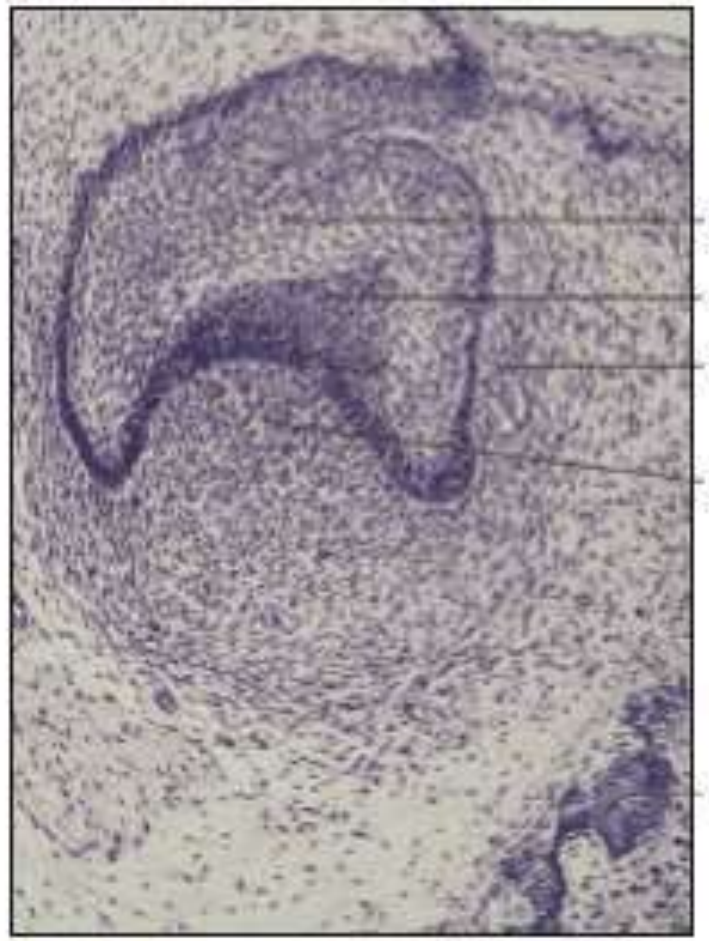


FIGURE 5-17 Advanced cap stage tooth germ showing the position of the enamel knot.

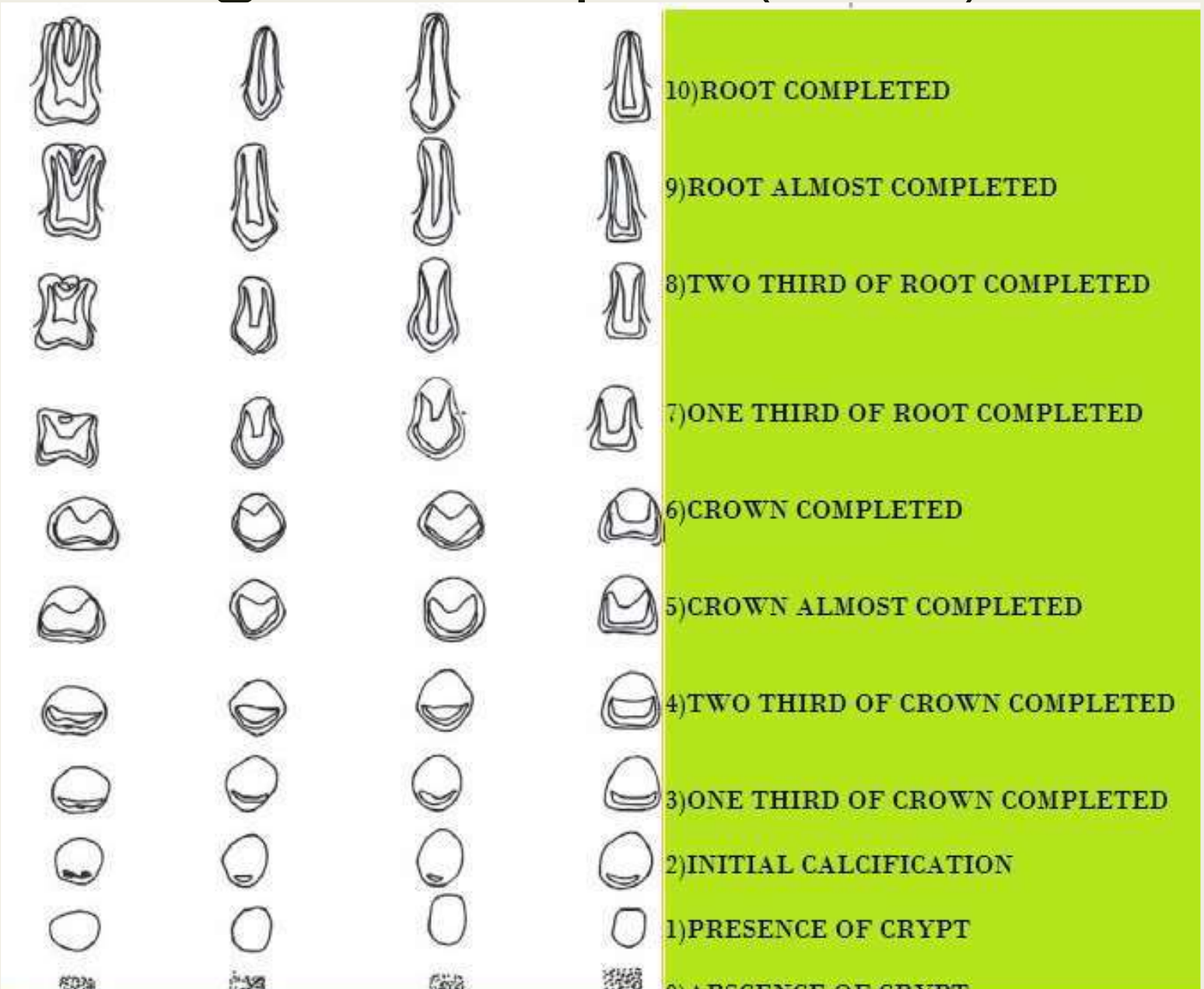
BELL STAGE

- Cells undergo definite morphological as well as functional changes and acquire appositional growth potential.
- Enamel organ consist of 4 layers: IEE, OEE, Stratum intermedium and Stellate Reticulum.
- Peripheral cells of dental papilla → odontoblast that form dentin
- Dental Sac → PDL
- At the end of this stage the cervical portion of Enamel organ gives rise to Epithelial root sheath of Hertwig.

ADVANCED BELL STAGE

- Deposition of the matrix of the dental hard tissue in a layer like pattern and is additive.

Nolla's Stages Of Eruption(1947)



DENTAL FORMULA

$$I\frac{2}{2}C\frac{1}{1}M\frac{2}{2}=10$$

$$I\frac{2}{2}C\frac{1}{1}P\frac{2}{2}M\frac{3}{3}=16$$

PERIODS OF OCCLUSAL DEVELOPMENT.

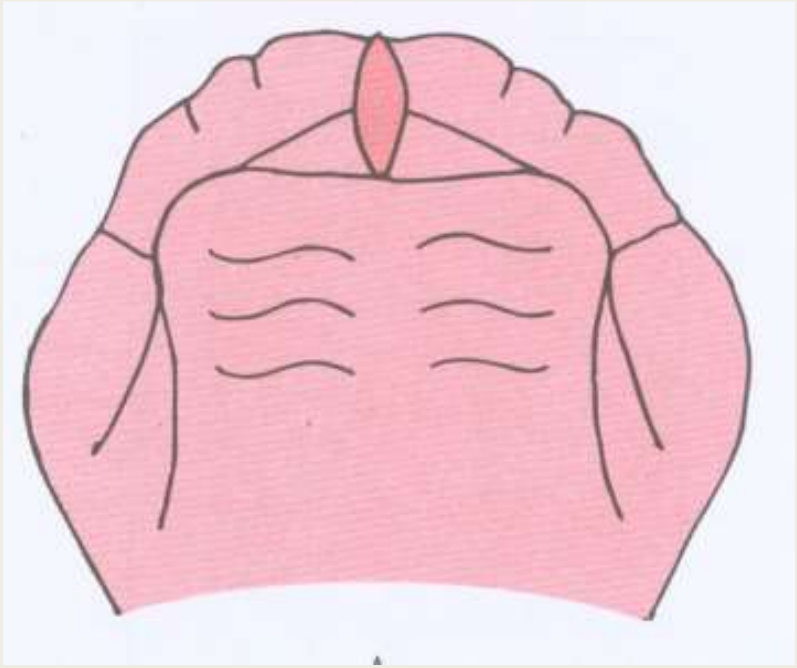
- PRE DENTATE PERIOD
- PRIMARY DENTITION PERIOD
- MIXED DENTITION PERIOD
- PERMANENT DENTITION PERIOD.

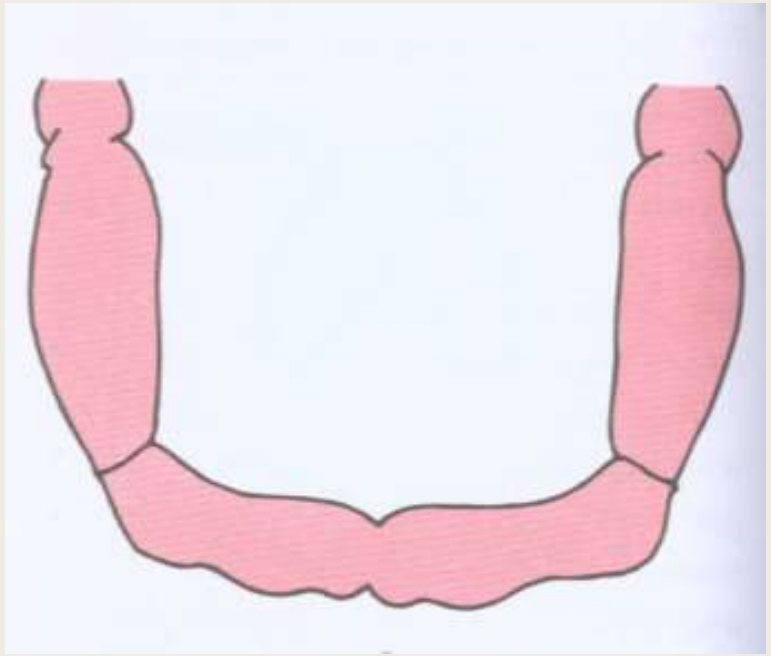
PRE DENTATE PERIOD.

- Lasts Up To 6 Months After Birth

GUM PADS

- Alveolar processes at the time of birth- gum pads.
- Pink in colour, firm and are covered by a dense layer of fibrous periosteum





- The gum pad soon gets segmented by a groove called transverse groove, & each segment is a developing tooth site.
- The pads get divided into ‘labio-buccal’ & ‘lingual portion’, by a dental groove.
- The groove between the canine and the 1st molar region is called the lateral sulcus, useful for judging the inter arch relationship at a very early stage

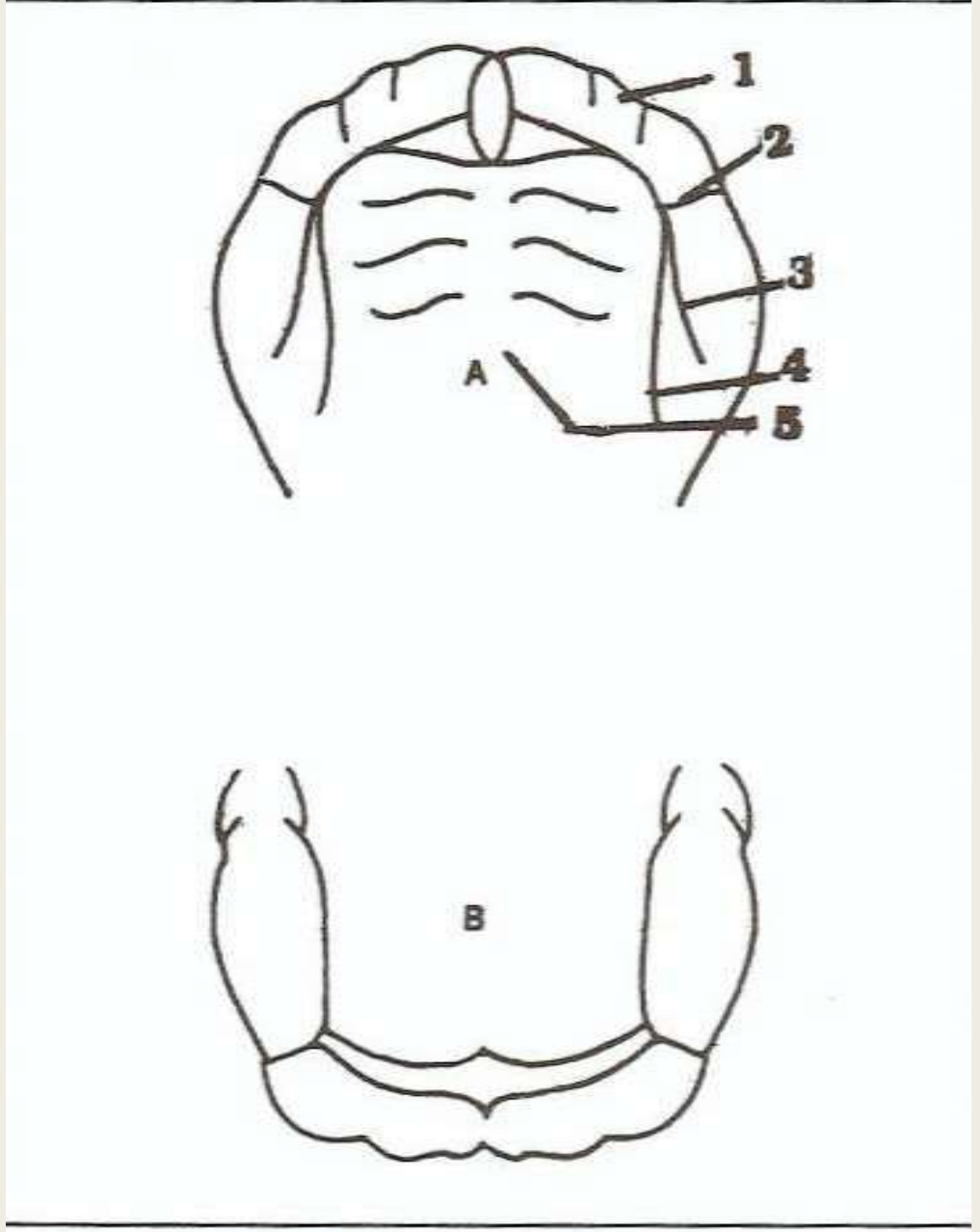
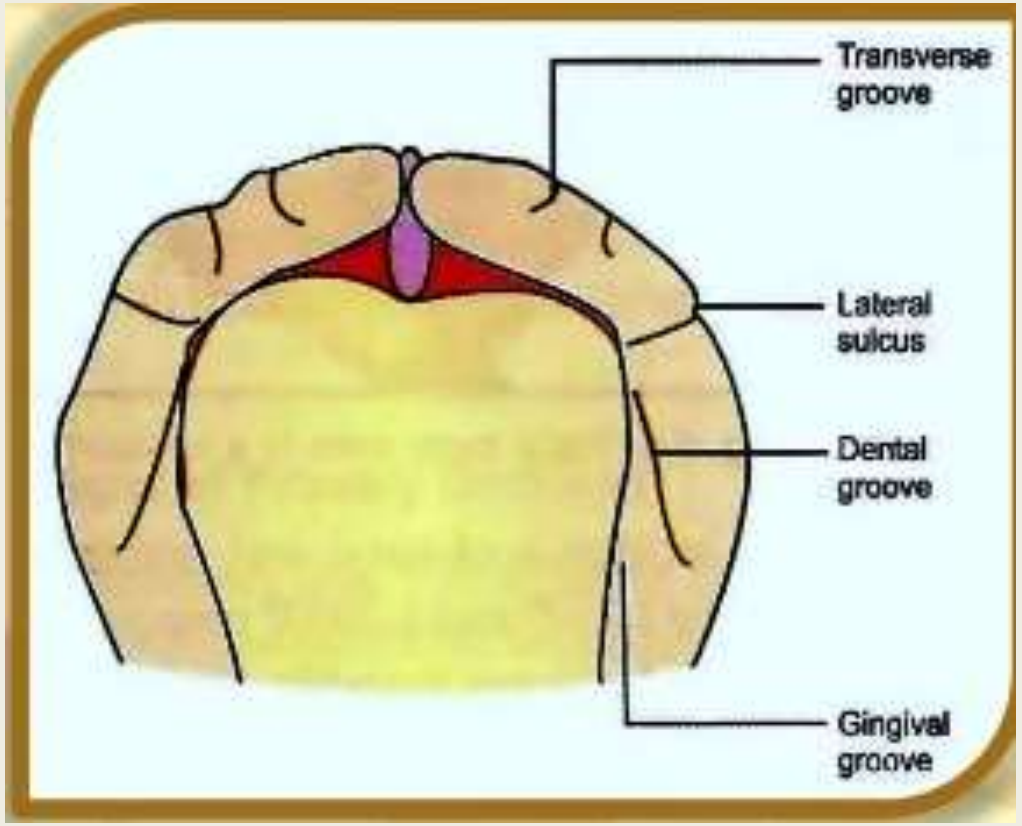


Fig. 5.1 GUMPADS a. Upper Gumpad b. Lower Gumpad 1. Labiobuccal 2. Lateral sulcus 3. Dental groove 4. Gingival groove 5. Palate

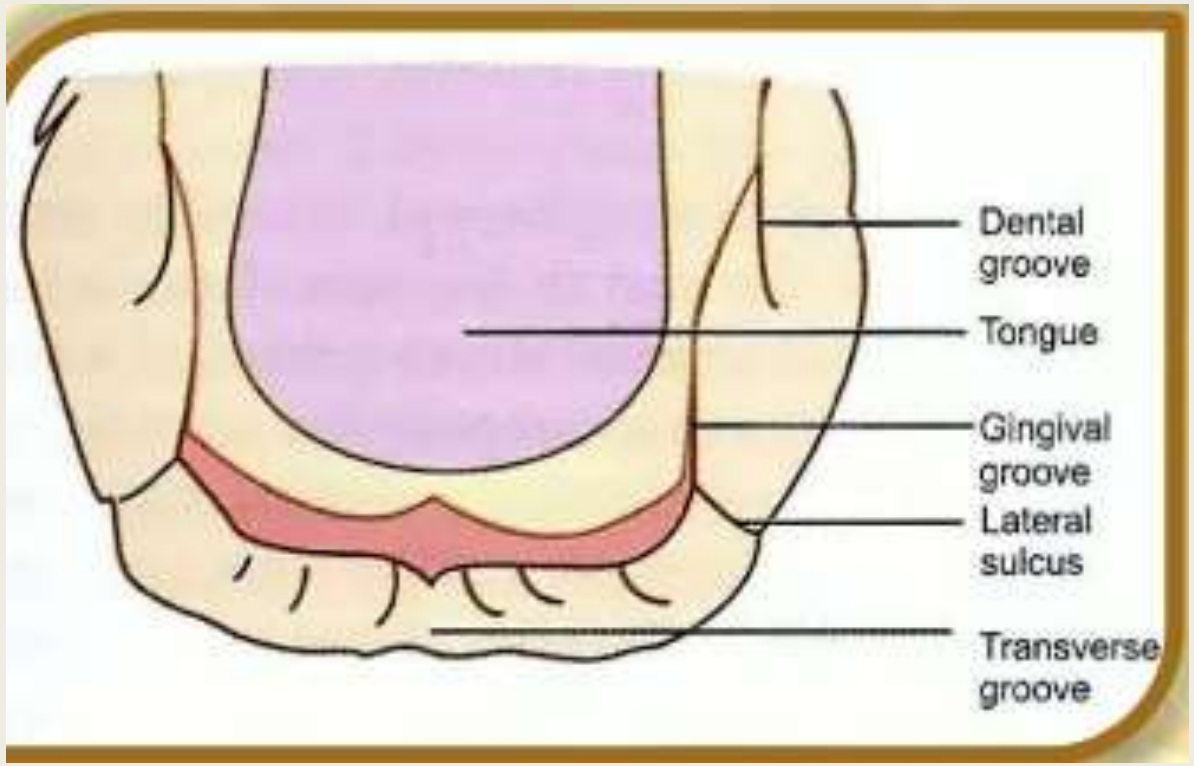
Maxillary gum pad:

- The upper gum pad is horse shoe shaped & shows:
- **Gingival groove**: separates gum pad from the palate.
- **Dental groove**: starts at the incisive papilla, extends backward to touch the gingival groove in the canine region & then moves laterally to end in the molar region.
- **Lateral sulcus**.



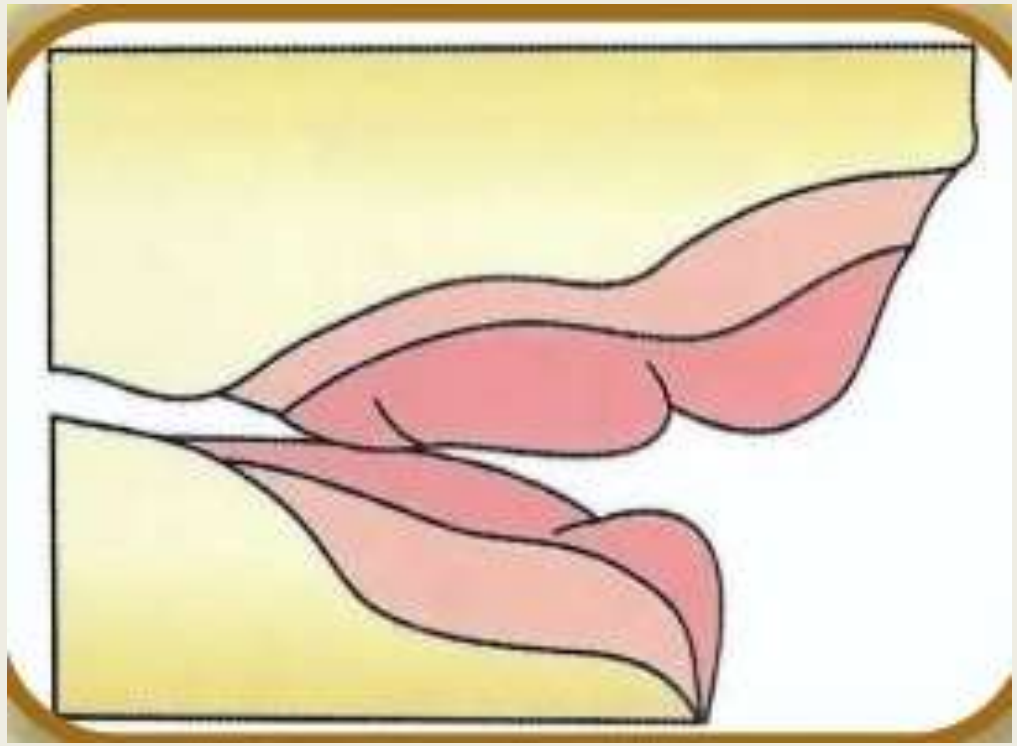
Mandibular gum pad:

- The lower gum pad is ‘U’ shaped and rectangular, characterized by:
- **Gingival groove**: lingual extension of the gum pads.
- **Dental groove.**
- **Lateral sulcus**



RELATIONSHIP OF GUM PADS

- Anterior open bite is seen at rest with the contact only at molar region
- Complete overjet
- Class II pattern with maxillary gum pad being more prominent.
- Mandibular functional movements are mainly vertical, and to a little extent antero-posterior.
- Lateral movements are absent.

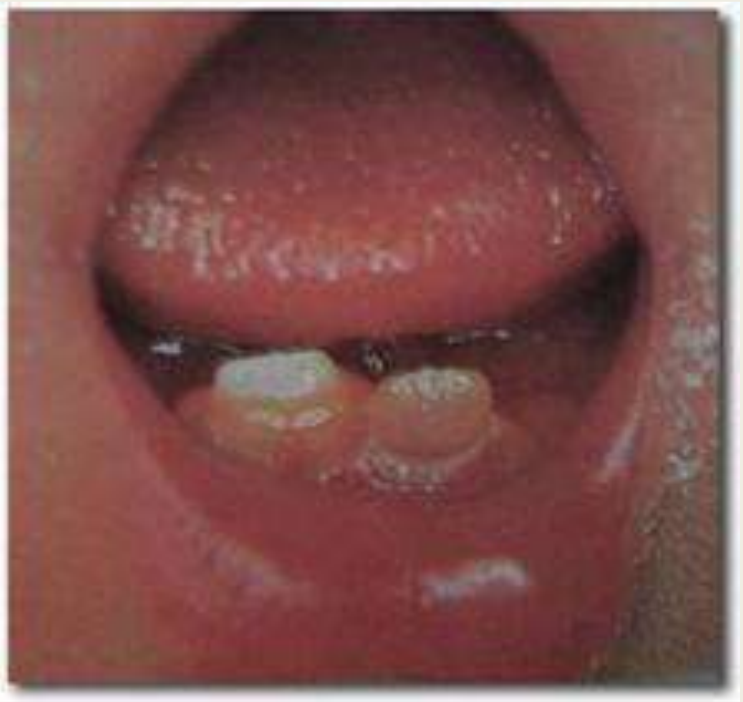


CLEANING OF GUM PADS

- Started within the first week of birth.
- The parent can be instructed to:- Lay the baby down with his/her head in your lap & feet pointing away.
- Take a small gauze (2” x2”) between thumb and forefinger & wipe vigorously over the gum pad .
- Infant tooth brush, Finger coats, Wipes are also used .
- Use adequate pressure just to remove the film that covers the gum pad.
- Clean at least every day twice after morning & last feed in the night.
- Duration of cleaning :- 2 to 3 minutes.

Status of Dentition at Birth

- Precociously Erupted Primary Teeth
- **NATAL TOOTH** : TOOTH SEEN IN ORAL CAVITY AT BIRTH
- **NEO NATAL TOOTH** : TOOTH THAT ERUPT INTO THE ORAL CAVITY WITHIN 30 DAYS AFTER BIRTH



NATAL/NEONATAL TOOTH CLASSIFICATION:

- **Hebling (1997)** classified natal teeth into 4 clinical categories

A. Shell-shaped crown poorly fixed to the alveolus by gingival tissue and absence of a root;

B. Solid crown poorly fixed to the alveolus by gingival tissue and little or no root;

C. Eruption of the incisal margin of the crown through gingival tissue

D. Oedema of gingival tissue with an unerupted but palpable tooth.

NATAL/NEONATAL TEETH:

- **Gender**
  - *Predilection for females*
- **Kates et al (1984)** reported a 66% proportion for females against a 31% proportion for males.
- **Incidence** –
  - *Incidence of Natal & Neonatal teeth has been estimated to be 1:1000 & 1:30,000. It is seen that-*
- 85% of natal or neonatal teeth are mandibular incisor.
- 11% Maxillary incisor
- 3% Mandibular cuspids
- 1% Maxillary cuspids/molar

- **Etiology**
- It has been related to several factors, such as:-
- Superficial position of the tooth germ
- Infection or malnutrition
- Eruption accelerated by febrile incidents or hormonal stimulation,
- Hereditary transmission of a dominant autosomal gene
- Osteoblastic activity inside the germ area related to the remodelling phenomenon and hypovitaminosis

Associated syndromes

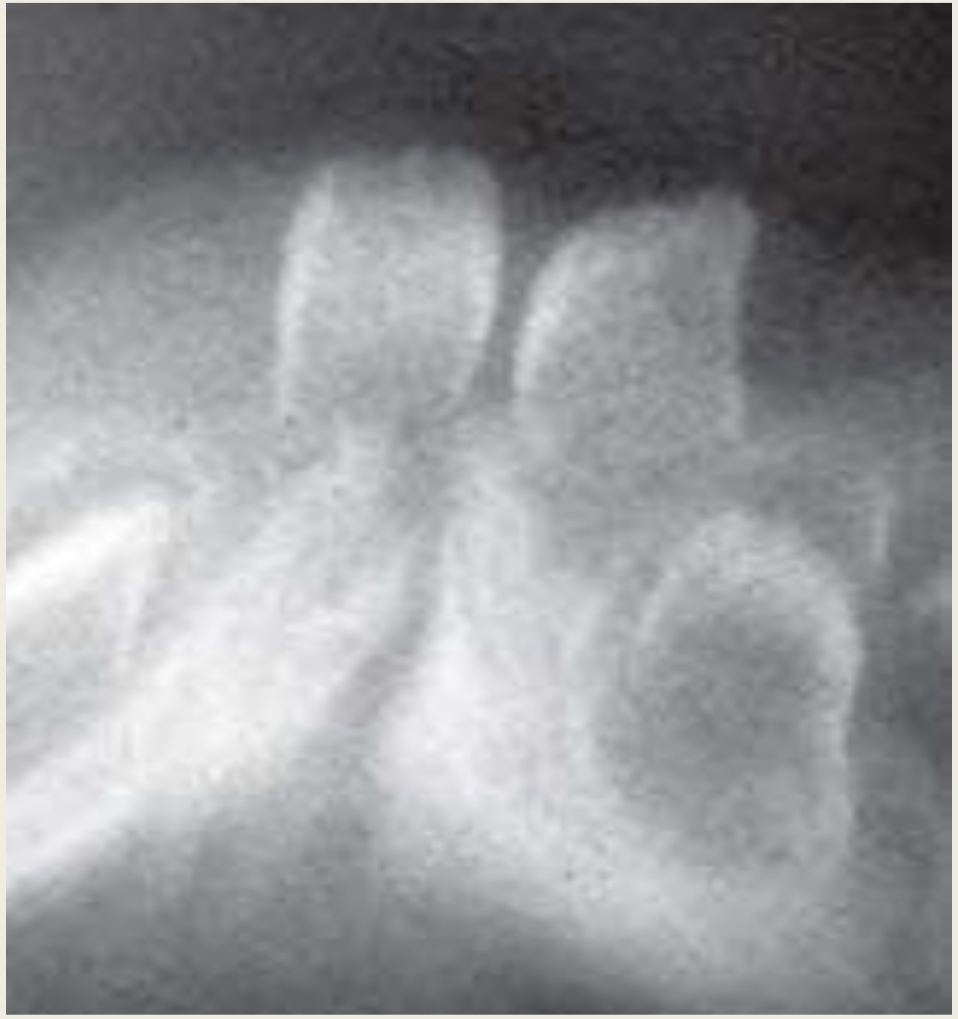
- Hallerman-Streiff
- Ellis-Van Creveld
- Craniofacial dysostosis
- Multiple steatocystoma
- Congenital pachyonychia
- Sotos Syndrome.

Complications:

- Interfere with feeding
- Risk of aspiration
- Traumatic injury to the baby's tongue and/or to the maternal breast
- Riga-Fede disease- oral condition found, rarely in new-borns manifests as an ulceration on the ventral surface of the tongue or on the inner surface of the lower lip.
- Caused by trauma to the soft tissue from erupted baby teeth

Diagnosis

- A **radiographic verification** of the relationship between a natal and/or neonatal tooth and adjacent structures, nearby teeth, and the presence or absence of a germ in the primary tooth area would determine whether or not the tooth belongs to the normal dentition (**Almeida CM et al 1997**)
- Most natal and neonatal teeth are primary teeth of the normal dentition and are not supernumerary teeth (**Brandt Sk et al 1983**)
- Correspond to teeth of the normal primary dentition in 95% of cases, while 5% are supernumerary (**Hawkins C 1932**)



Treatment

- If the erupted tooth is diagnosed as a tooth of the normal dentition -- maintenance of these teeth in the mouth is the first treatment option, unless this would cause injury to the baby (**Chow MH 1980, Roberts MW 1992**)

- When well implanted-- these teeth should be left in the arch and their removal should be indicated only when they interfere with feeding or when they are highly mobile, with the risk of aspiration (**Toledo AO 1996**)

- Reasons for removal -- The risk of dislocation and consequent aspiration, traumatic injury to the baby's tongue and/or to the maternal breast, (**Kates GA et al 1984**)

- **Martins et al (1998)** suggested smoothing of the incisal margin to prevent wounding of the maternal breast during breast feeding.

- If the treatment option is extraction, certain precautions should be taken :
- Avoiding extraction up to the 10th day of life to prevent haemorrhage
- Assessing the need to administer vitamin K before extraction (0.5-1.0 mg IM)
- Considering the general health condition of the baby
- Avoiding unnecessary injury to the gingiva
- Being alert to the risk of aspiration during removal.

STATUS OF PREDENTATE PERIOD

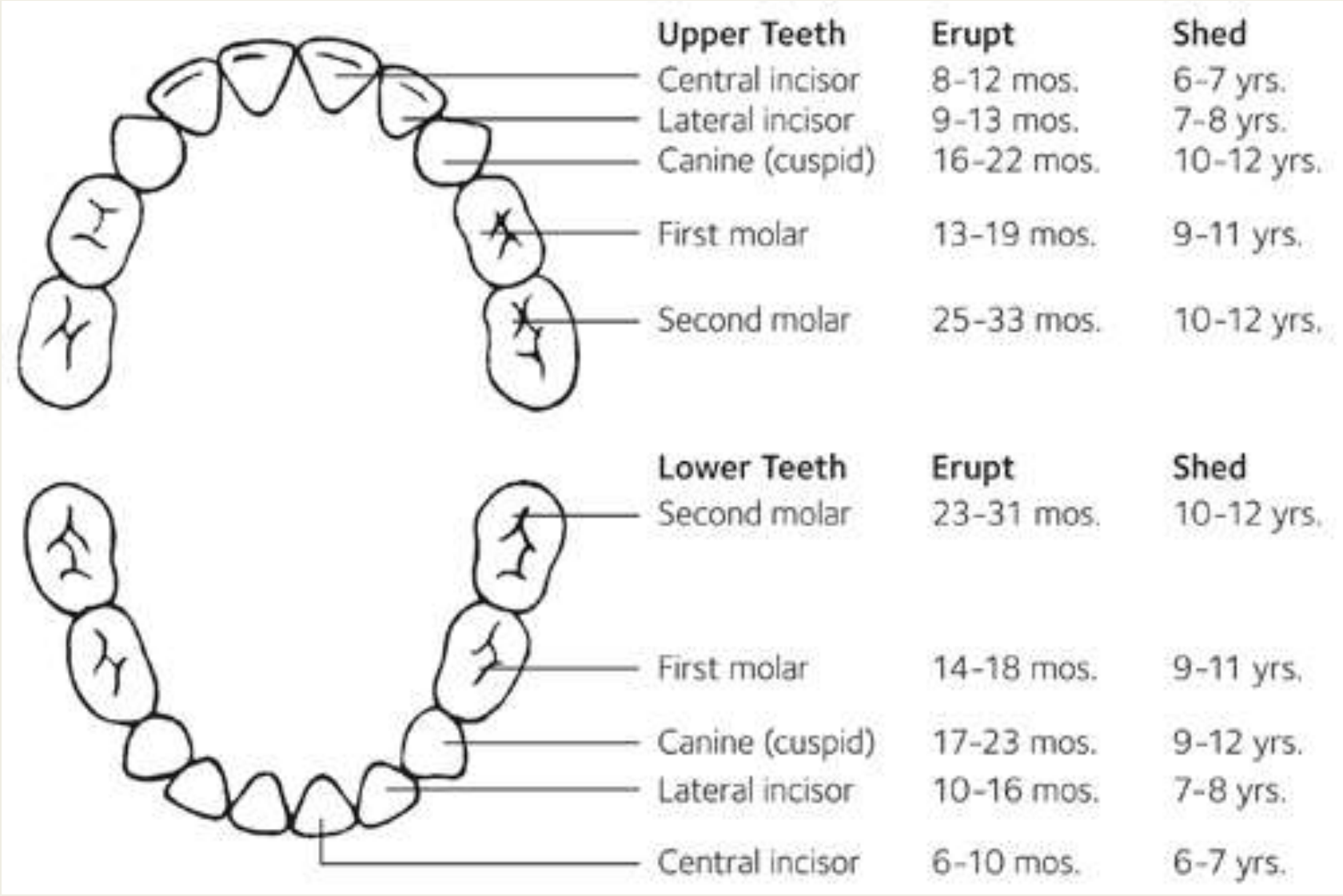
- Neonate is without teeth for about 6 months of life.
- At birth gum pads are not sufficiently wide to accommodate the developing incisors which are crowded in their crypts.
- During the first year of life the gum pads grow rapidly permitting the incisor to erupt in good alignment.
- Very rarely teeth are found to have erupted at the time of birth or within a month after birth.

PRIMARY DENTITION PERIOD

- From around the 6th month to 6 years

SEQUENCE OF ERUPTION

- A B D C E



Upper Teeth	Erupt	Shed
Central incisor	8–12 mos.	6–7 yrs.
Lateral incisor	9–13 mos.	7–8 yrs.
Canine (cuspid)	16–22 mos.	10–12 yrs.
First molar	13–19 mos.	9–11 yrs.
Second molar	25–33 mos.	10–12 yrs.

Lower Teeth	Erupt	Shed
Second molar	23–31 mos.	10–12 yrs.
First molar	14–18 mos.	9–11 yrs.
Canine (cuspid)	17–23 mos.	9–12 yrs.
Lateral incisor	10–16 mos.	7–8 yrs.
Central incisor	6–10 mos.	6–7 yrs.

RULE OF “7 + 4”

- A helpful mnemonic to remember the timing of primary eruption is the 7+4 rule.
- At 7 months of age, children should have their first teeth;
- At 11 months (4 months later),they should have 4 teeth.
- At 15 months of age (4 months later), they should have 8 teeth;
- At 19 months, they should have 12 teeth;
- At 23 months, they should have 16 teeth;
- And at 27 months, they should have 20 teeth.

Status of Dentition

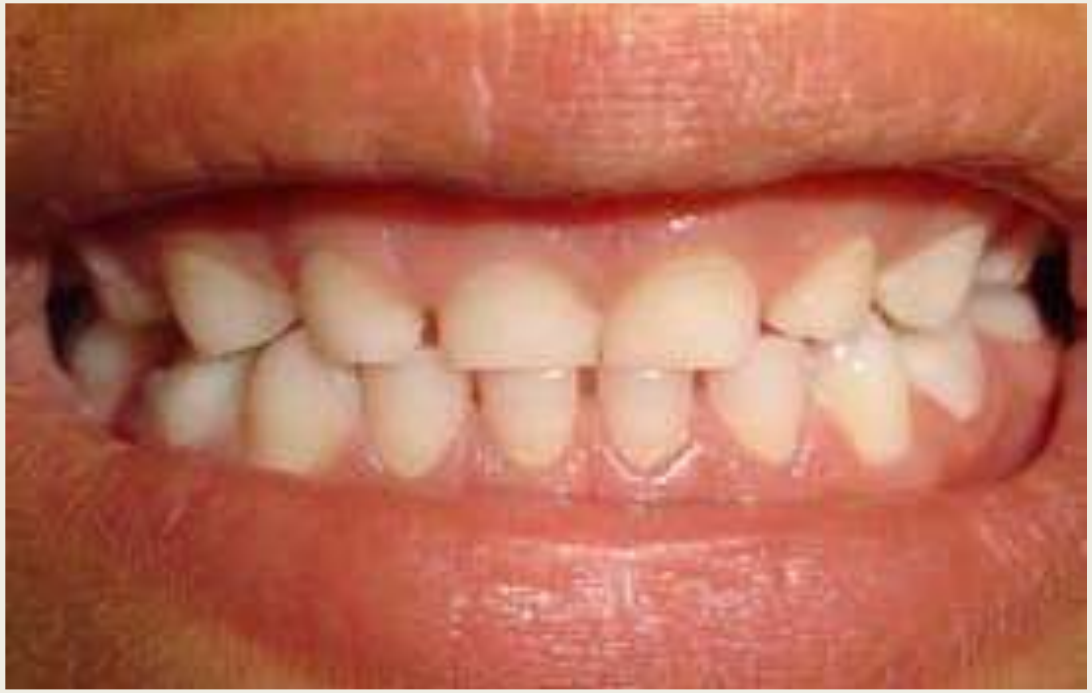
- **At around 5 – 6 Years**
- There are 48 teeth/parts of teeth present in the jaw.
- It is at this time that there are more teeth in the jaws than at any other time.

CHARACTERISTICS OF PRIMARY DENTITION

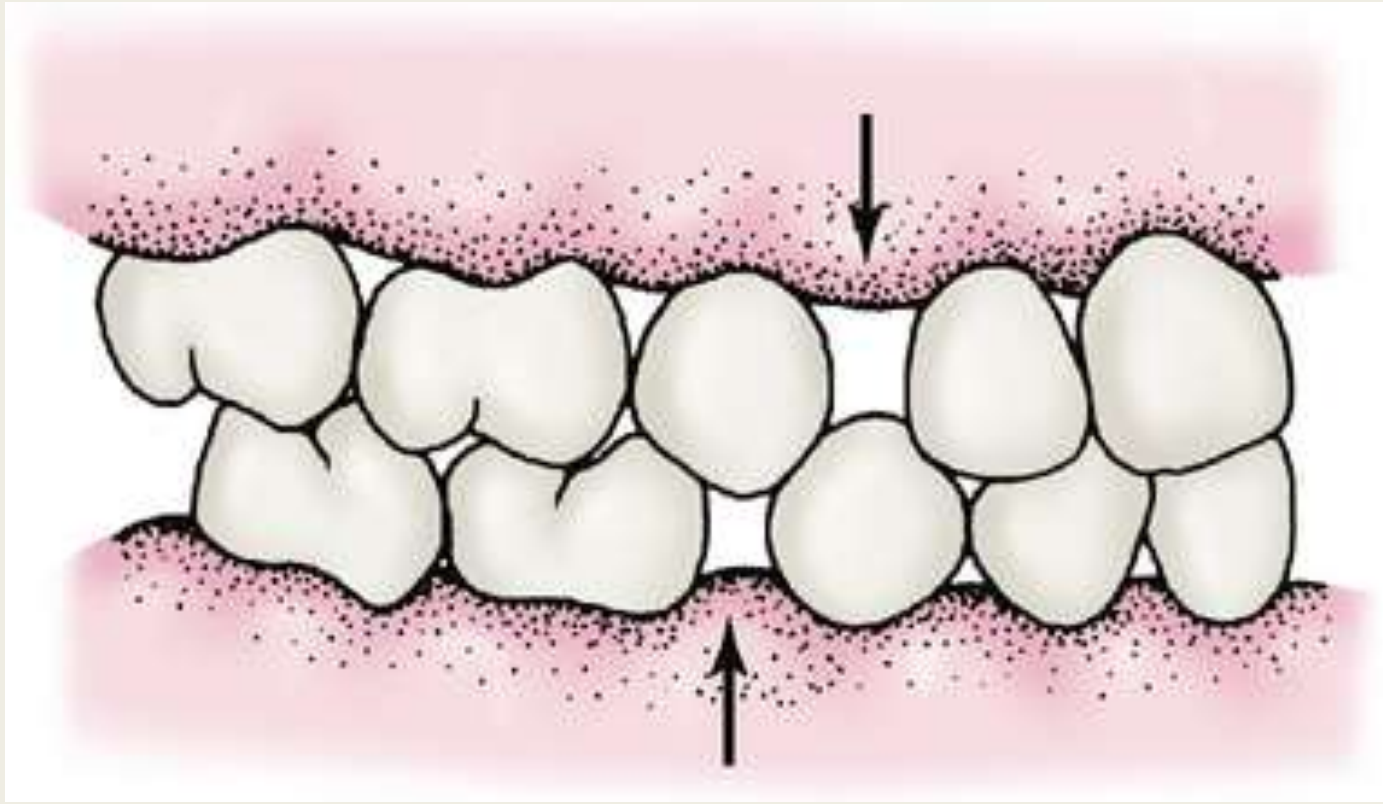
- Spaced anteriors
- Shallow overbite and overjet
- Straight terminal plane
- Class I molar and Canine Relationship
- Vertical inclination of anterior teeth
- Ovoid arch form

Spacing:

- 2 types of dentition are seen:
- **Spaced dentition** -
- usually seen to accommodate the larger permanent teeth in the jaws.
- More prominent in the anterior region, and are called ‘physiological spacing’ or ‘developmental spacing’.
- Absence of spaces in the primary dentition is an indication that crowding of teeth may occur when the larger permanent teeth erupt.



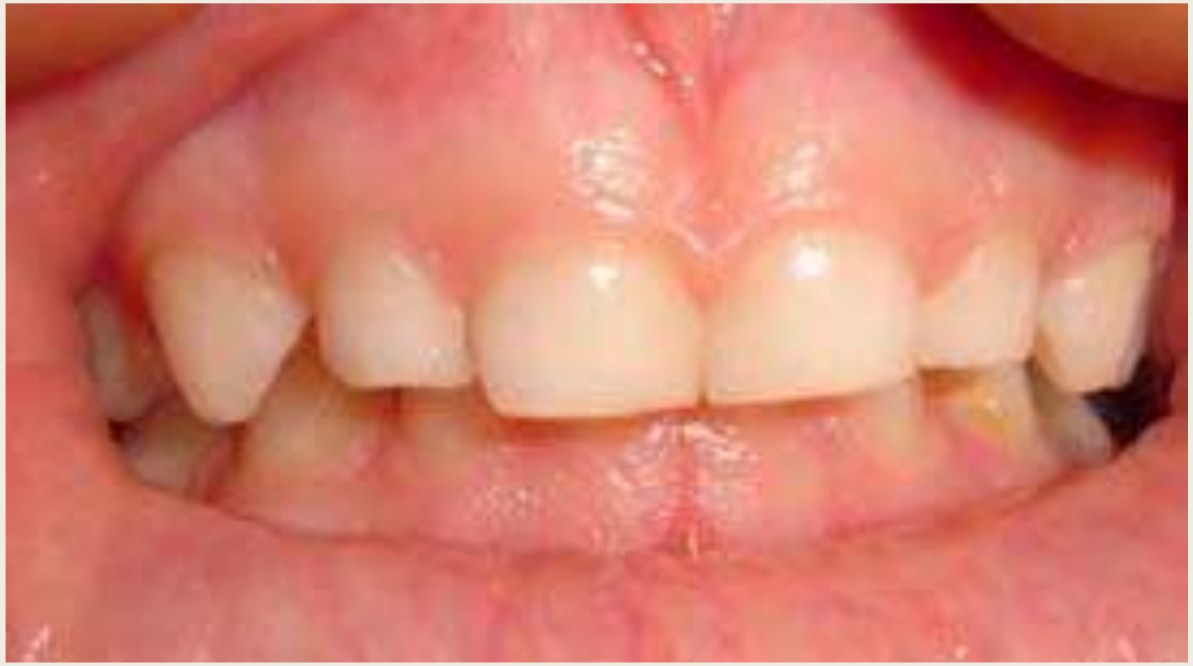
- Spacing seen mesial to maxillary canines and distal to the mandibular canines are wider than in other spaces.
- These physiologic spaces are called Primate Spaces or Simian Spaces.
- They help in placement of canine cusp of the opposing arch.
- This space is used for early mesial shift.



- **Incidence :**
- 70% in maxillary arch
- 63% in mandibular arch
- The amount of primate space in maxilla is around 1.7mm. & in mandible 1.5 mm.

B)Non- spaced dentition

- Teeth are present without any spaces in between the teeth
- Due to narrow dental arches or if teeth are wider than usual
- May indicate crowding in developing permanent dentition

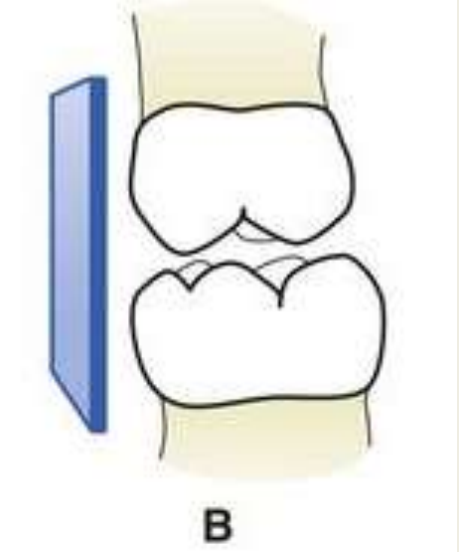


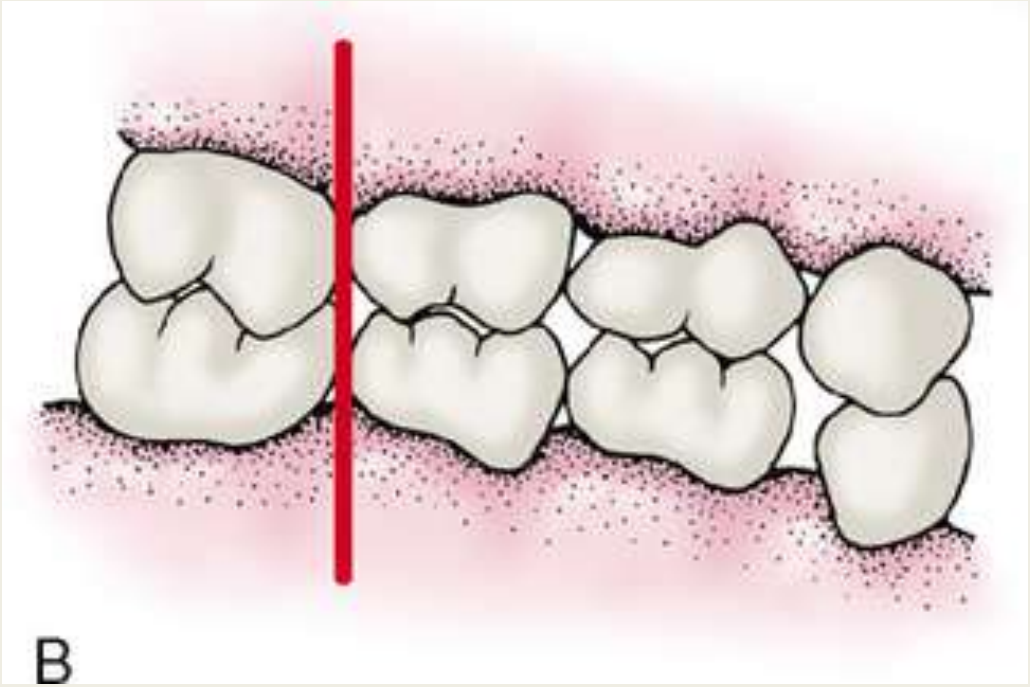
Shallow overjet & overbite

- Initially a deep bite may occur due to the fact that the deciduous incisors are more upright than their successors.
- The lower incisal edges often contact the cingulum area of the maxillary incisors.
- This deep bite is later reduced by:
  - *Eruption of deciduous molars.*
  - *Attrition of incisors.*
  - *Forward movement of the mandible due to growth*
- (The average overjet in primary dentition is 1-2 mm.)

FLUSH TERMINAL PLANE

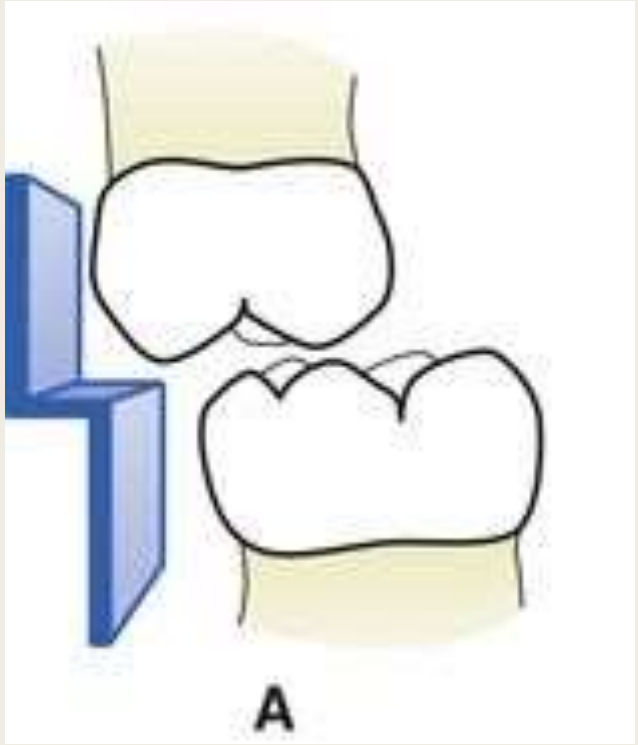
- If the distal surface of maxillary and mandibular deciduous second molars are in the same vertical plane; then it is called a flush terminal plane
- It is a normal molar relationship in the primary dentition, because the mesiodistal width of the mandibular molar is greater than the mesiodistal width of the maxillary molar.

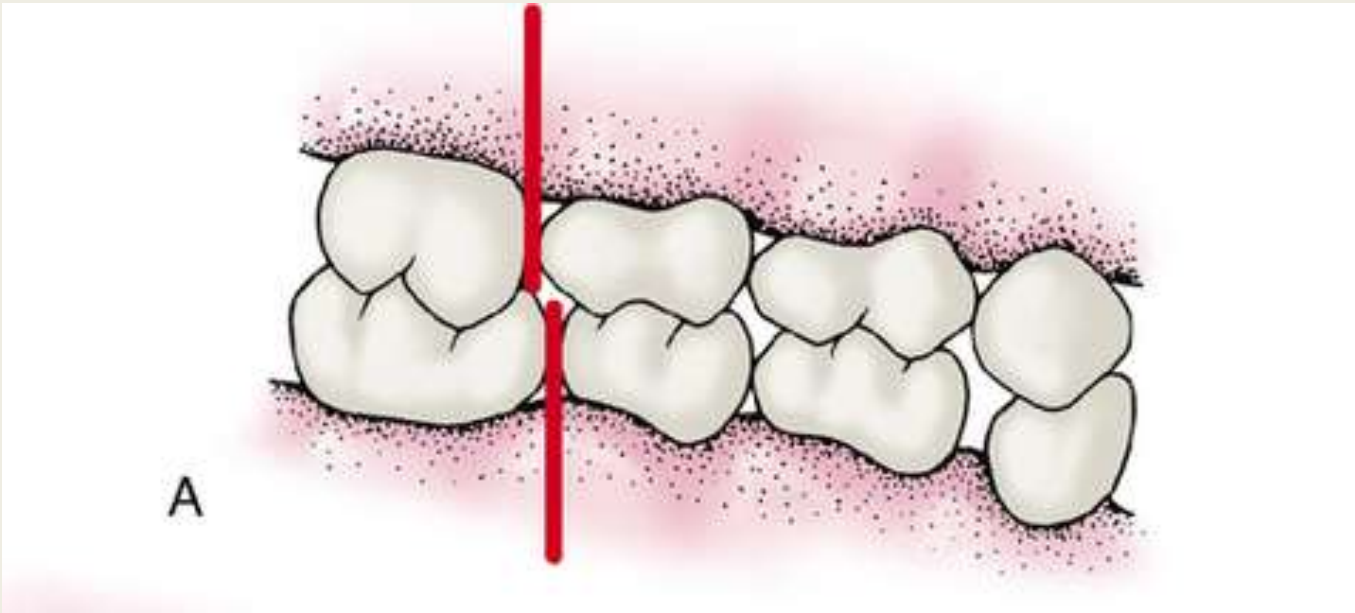




MESIAL STEP

- Distal surface of mandibular deciduous second molar is mesial to the distal surface of maxillary deciduous second molar.

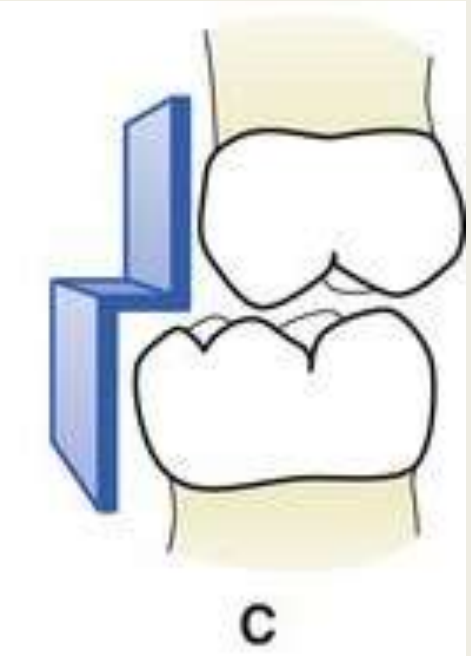


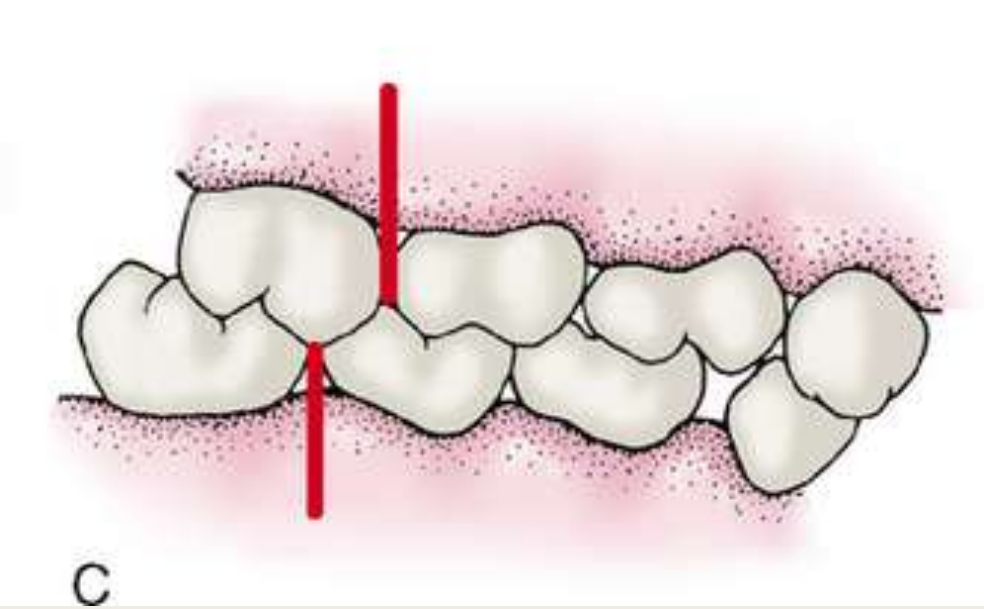


DISTAL STEP

- Distal surface of mandibular second deciduous molar is more distal to the distal surface of the maxillary second deciduous molar

- Nanda *et al*. reported that 52% of Indian children had flush terminal relationship, 25·5% had mesial step, 9% had distal step and 7·5% had asymmetric molar relationship





CANINE RELATIONSHIP

- Relationship of maxillary & mandibular deciduous canines is one of the most stable in primary dentition
- Classified as:
  - *CLASS I*
  - *CLASS II*

DEVELOPMENT OF PRIMARY OCCLUSION

- Teeth are guided into their occlusal position by functional matrix of muscles during the active growth of facial skeleton.
- Low cusp height and occlusal surface wear contribute to the adaptability of primary occlusion.
- With the functioning of peri-oral muscle the arch shape is altered by muscular activities

- Primary dental arch is ovoid and the tongue plays a role in shaping of dental arches in early stages.
- With the eruption of the primary first molar the first three dimensional occlusal relationship is established.
- All primary teeth except mandibular central incisors & maxillary 2nd molar, occlude with 2 tooth of opposing jaw.

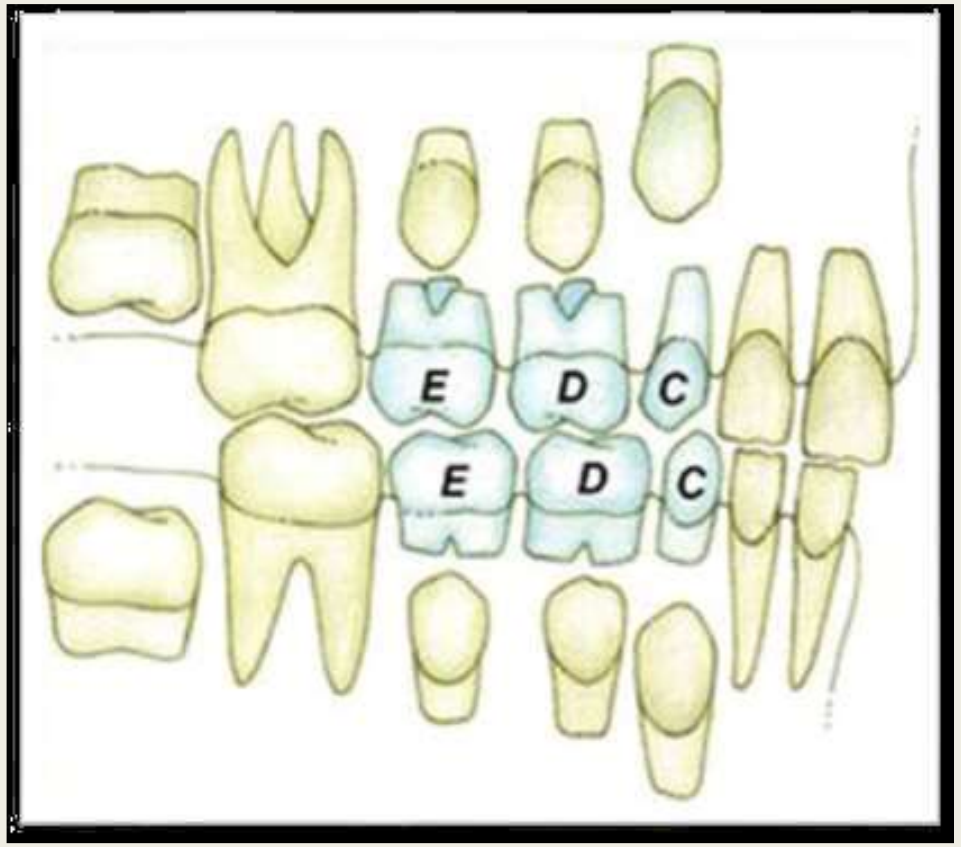
- In Maxilla:
- Increased intermolar width of 2mm between 3-5 yrs.
- Palatal vault increases from birth to about 12 months and remains relatively constant throughout the first 2years.

- In Mandible:
- Increased intermolar width of 1.5mm between 3-5 yrs.
- Increase in height of alveolar bone

MIXED DENTITION PERIOD

- **DEFINITION:** The period during which both primary & permanent teeth are in the mouth together is known as the mixed dentition period

- Around 6 years- 12 years

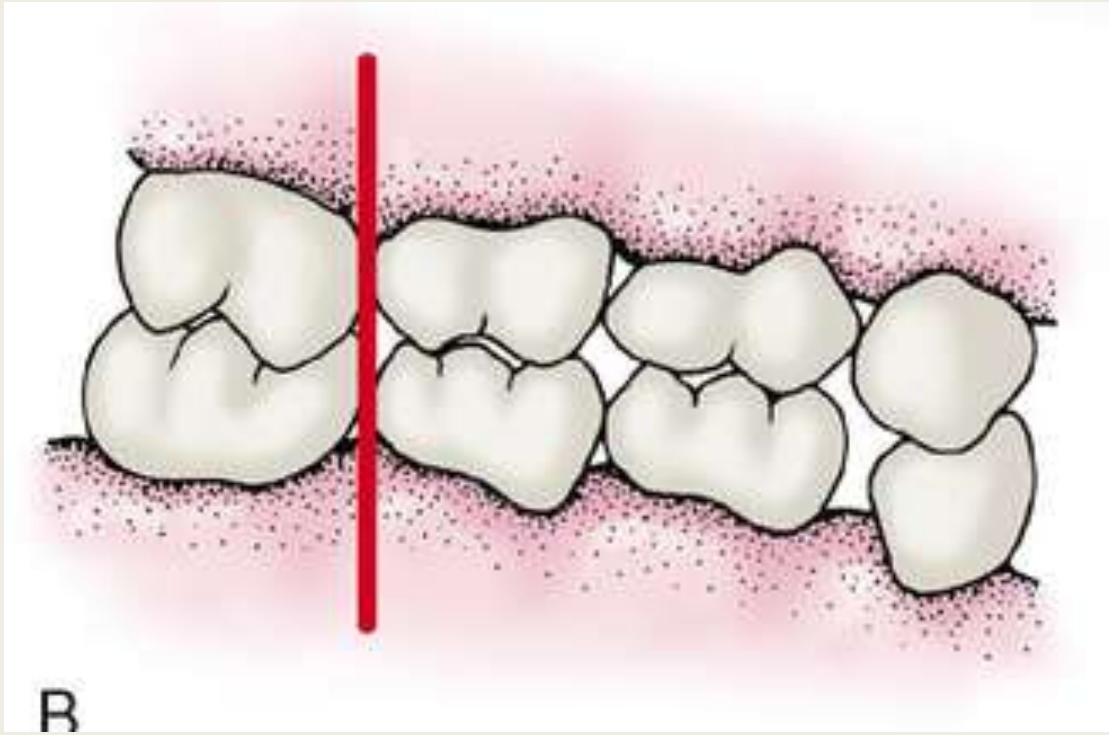


- **The mixed dentition period can be divided into three phases:**

- First transitional period.(6 to 8 years of age)
- Inter-transitional period.
- Second transitional period.(10 to 12 years of age)

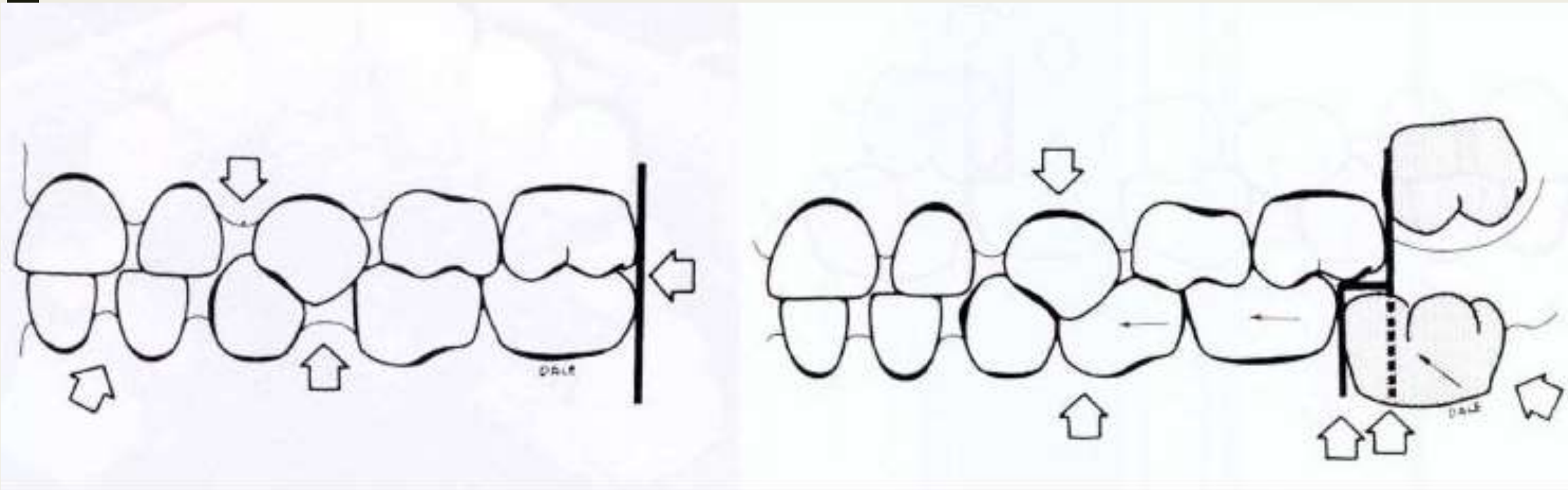
First transitional period.

- A)EMERGENCE OF THE FIRST PERMANENT MOLAR.
- Permanent first molars erupt at the age of 6 years.
- They are guided into position by the distal surface of the primary second molars.
- The future molar relationship of the permanent dentition depends upon the distal relationship of upper and lower primary second molar

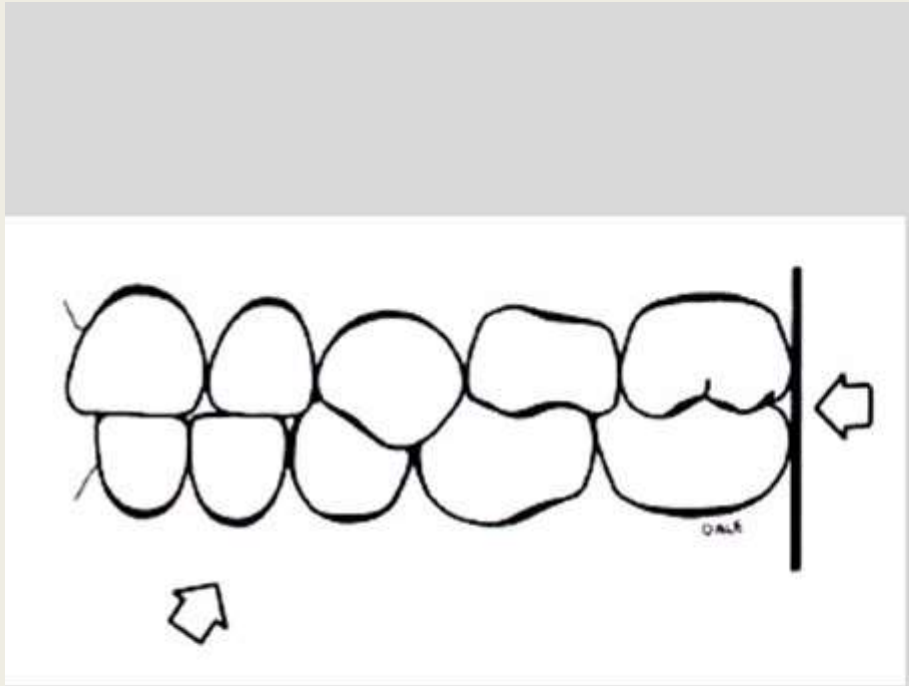


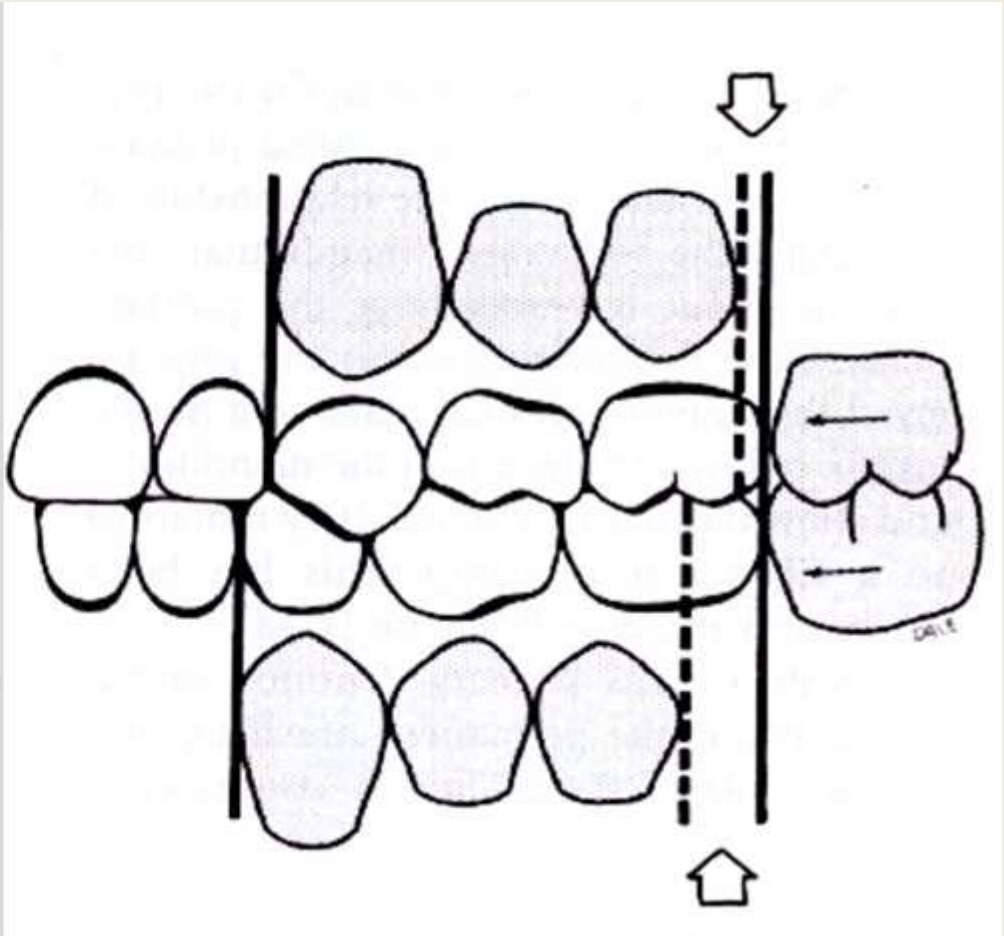
- Shift in lower molar from the initial relation to the final occlusion can occur in two ways.
- Designated as Early and Late mesial shift.
- EARLY SHIFT → USES PRIMATE SPACE
- LATE SHIFT → USES LEEWAY SPACE.

EARLY MESIAL SHIFT



LATE MESIAL SHIFT





Occlusion of first permanent molar when deciduous molars are in flush terminal plane relation.

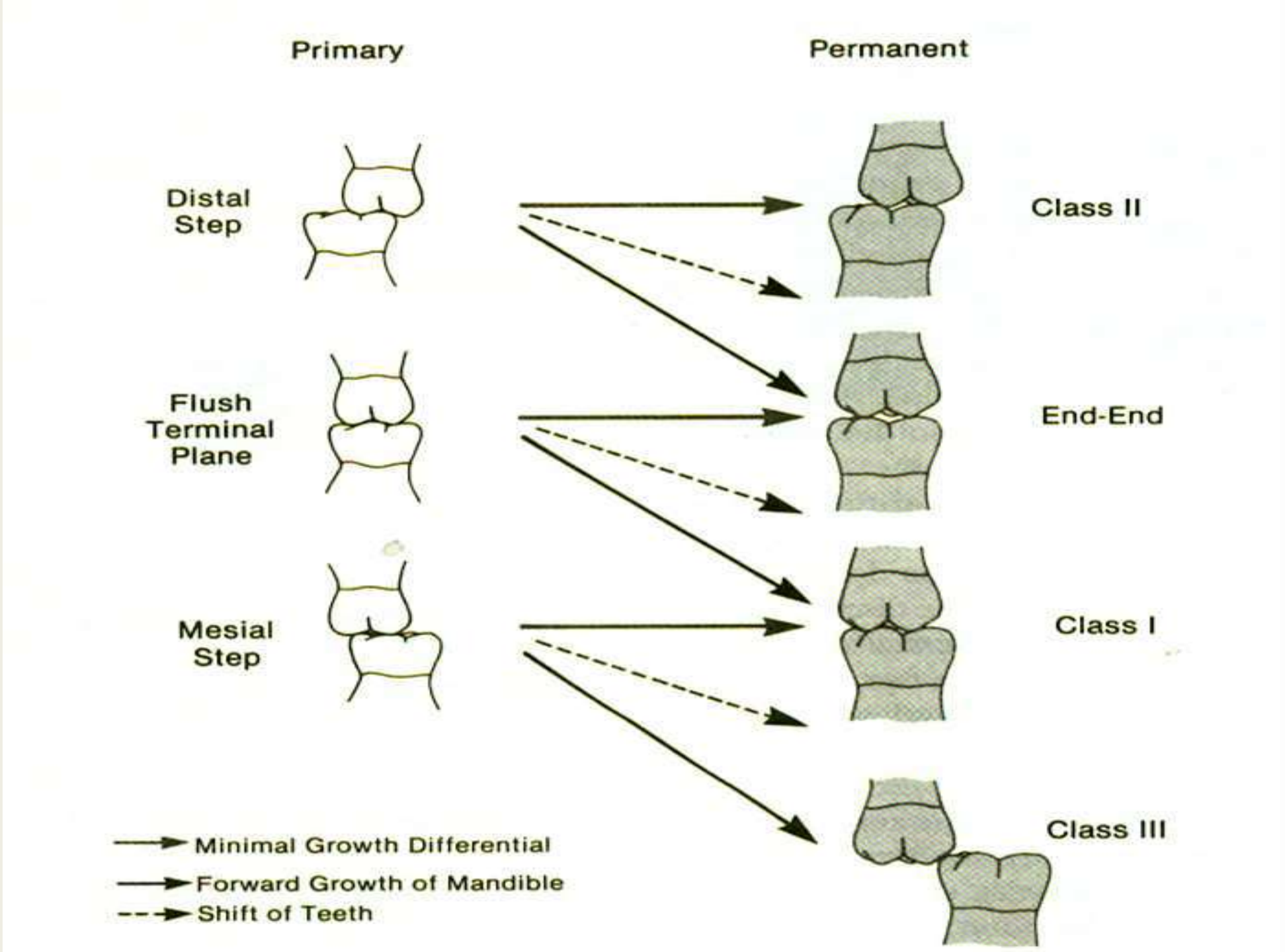
- Erupting first permanent molars may also be in a flush or end on relation.
- For transition into class I molar relation it utilizes primate space and by differential forward growth of the mandible.
- Early shift occurs during early mixed dentition period.
- In absence of primate space, after exfoliation of primary second molar the mandibular permanent 1^{st} molar utilizes the leeway space of Nance and drift mesially.
- This occurs in late mixed dentition period.
- And it is called as late mesial shift.

- ***Occlusion of first permanent molar when deciduous molars are in mesial step relation.***

- In such case permanent molars erupt directly into Angle's Class I occlusion.
- Mesial step terminal plane occurs due to early forward growth of the mandible.
- If the differentiated growth of the mandible is in a forward direction , it can lead to an Angle's class III molar relation
- If it is minimal it can establish a Class I molar relationship.

- ***Occlusion of first permanent molar when deciduous molars are in distal step terminal plane relation.***

- The erupting permanent molars may be in Angle's Class II occlusion.
- Later the relation may shift to Class I if the forward mandibular growth is extensive.

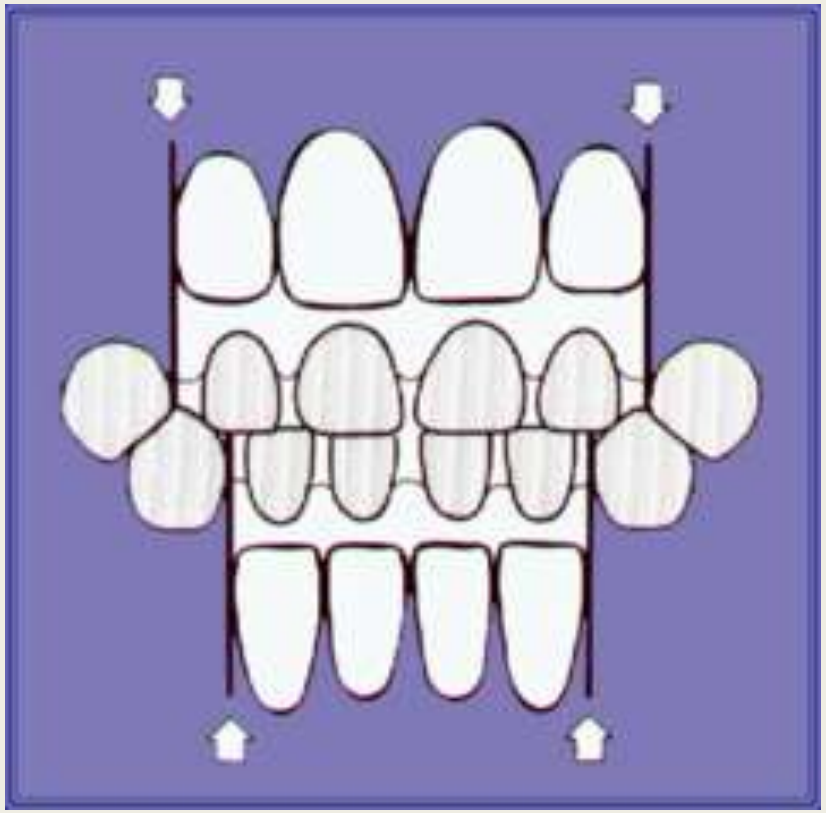

Primary
Permanent
Distal Step
Flush Terminal Plane
Mesial Step
Class II
End-End
Class I
Class III
Minimal Growth Differential
Forward Growth of Mandible
Shift of Teeth

B)THE EXCHANGE OF INCISORS

- During the first transitional period the deciduous incisors are replaced by the permanent incisors.
- 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’.
- **7.6 mm in the maxillary arch.**
- **6 mm in the mandibular arch. (Wayne).**

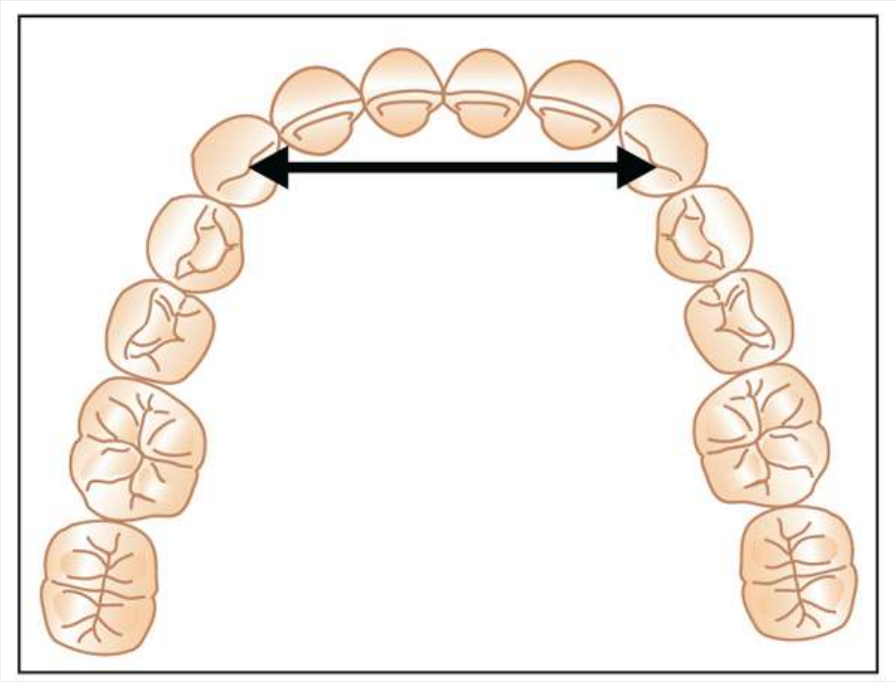
- Incisal liability is overcome by:

- ***Interdental physiological spacing in the primary incisor region*.**
- (4 mm in maxillary arch & 3 mm in mandibular arch)



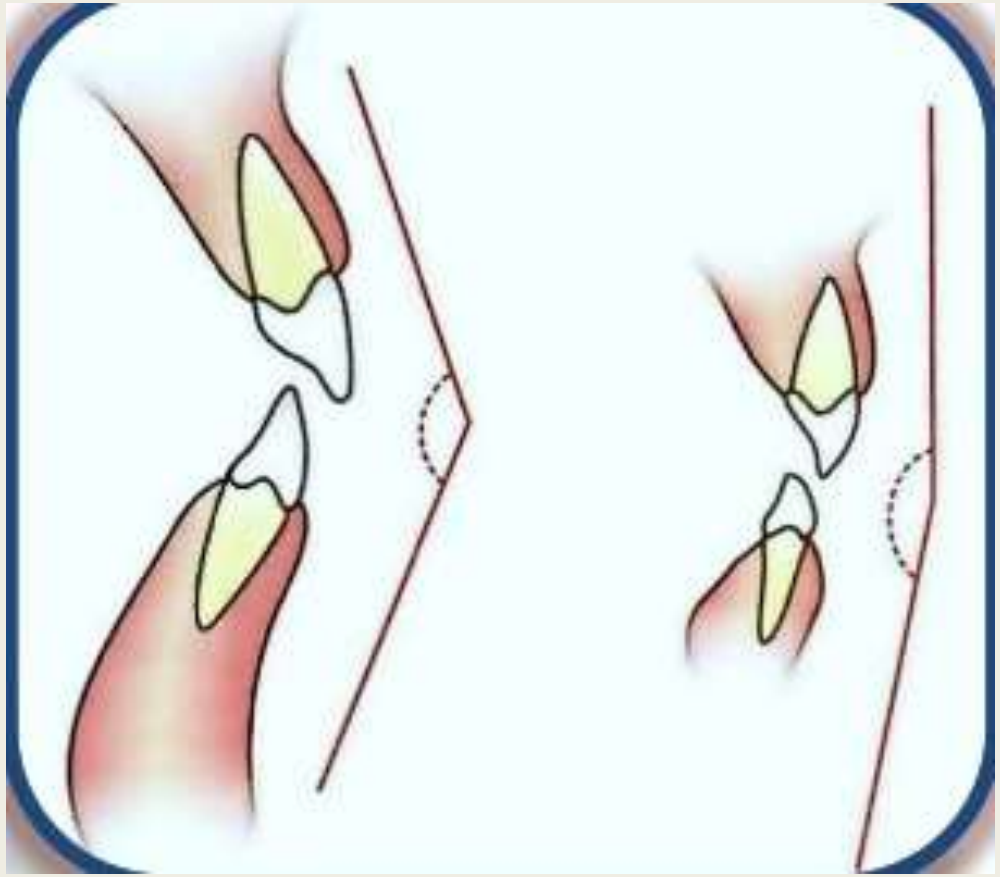
- ***Increase in inter-canine arch width*:**

- Significant amount of growth occurs with the eruption of incisors and canines.



- ***Change in inclination of permanent incisors*.**

- Primary teeth are upright but permanent teeth incline to the labial surface thus decreasing the inter incisal angle from about 151degrees to 124 degrees in permanent dentition.
- This increases the arch perimeter.



Inter Transitional period

- This is a stable phase, little changes take place in the dentition.
- The teeth present are the permanent incisors and first molar along with the deciduous canines and molars.
- This phase prepares for the second transitional phase.

- Some of the features of this stage are:

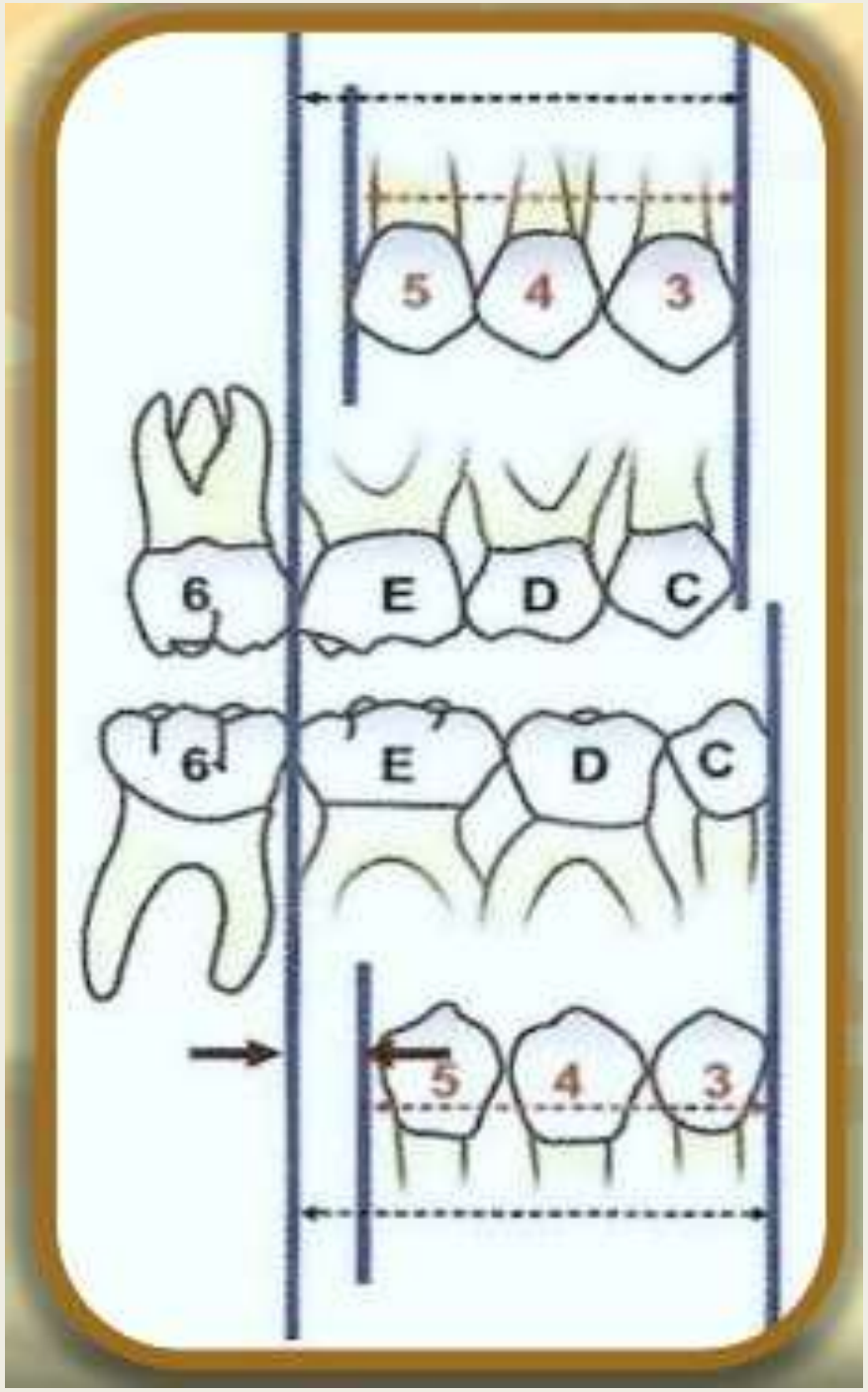
- Any asymmetry in emergence and corresponding differences in height levels or crown lengths between the right and left side teeth are made up.
- Root formation of emerged incisors, and molars continues, along with concomitant increase in alveolar process height
- Resorption of roots of deciduous canines and molars.

Second Transitional Period.

- The second transitional period is characterized by the replacement of the deciduous molars and canines by the premolars and permanent canines respectively.
- The features of second transitional period are:
  - *Leeway Space of Nance.*
  - *Ugly Duckling Stage.*

Leeway Space of Nance

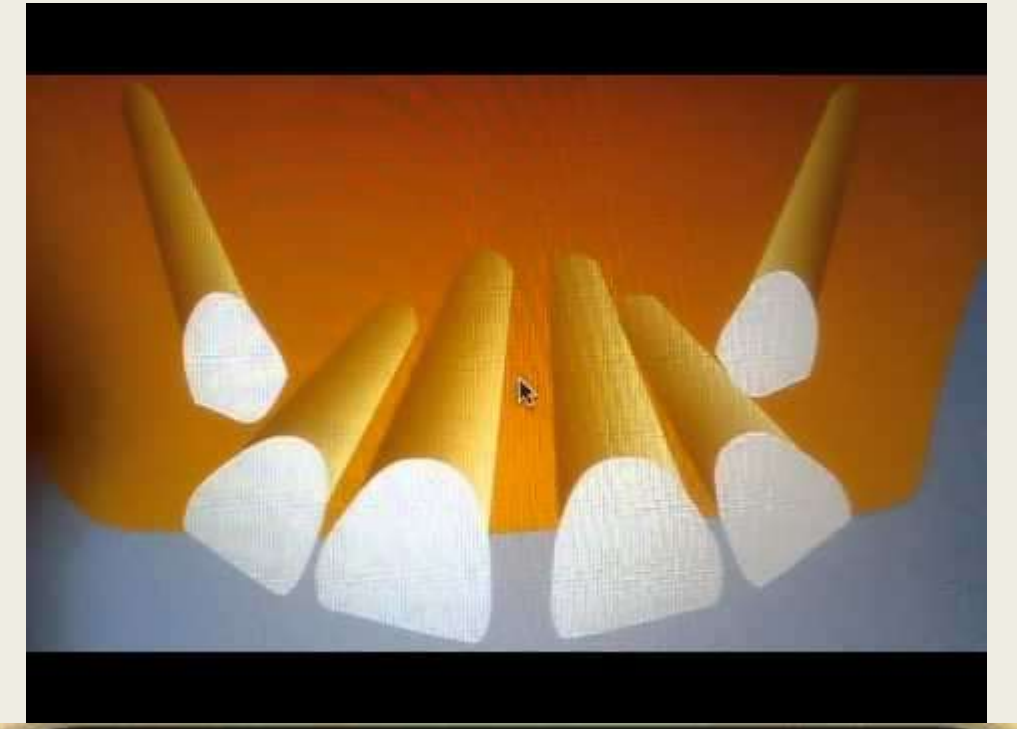
- The combined mesio-distal width of the permanent canine and premolars is usually less than that of the deciduous canines and molars.
- This surplus space is called Leeway Space of Nance.
- Maxillary arch=1.8mm (0.9mm on each side)
- Mandibular arch=3.4mm (1.7mm on each side)
- Utilized for the mesial drift of the mandibular molars to establish Class I molar relation.

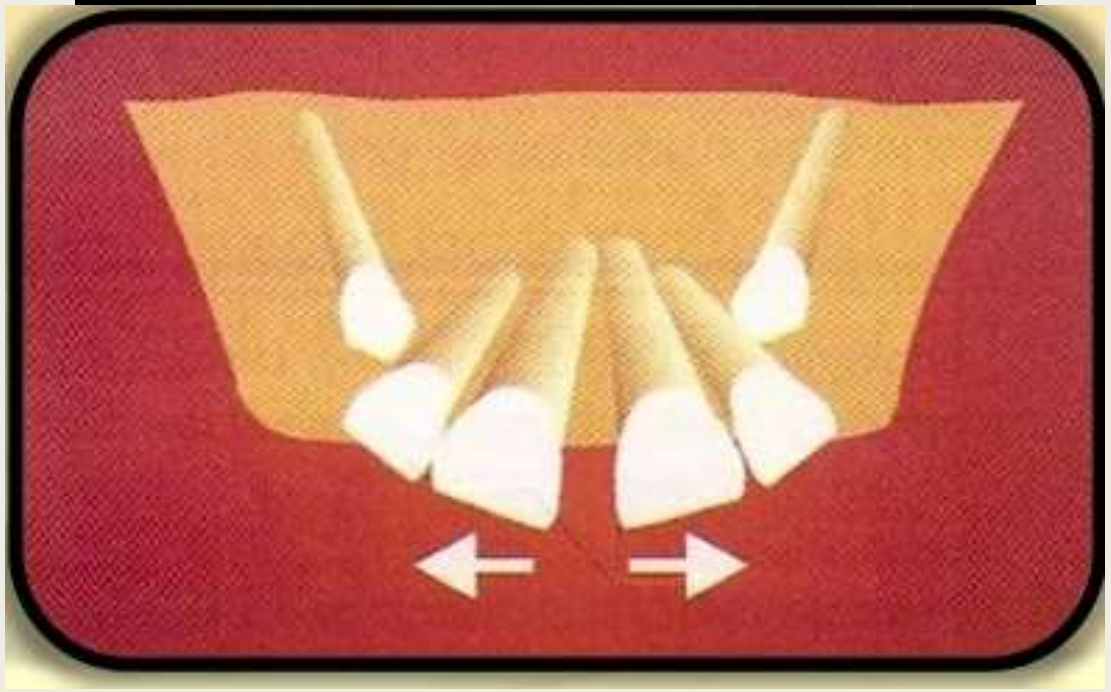


Ugly Duckling Stage (Broadbent's phenomenon,1937)

- It is a transient or self correcting malocclusion seen in the maxillary incisor region.
- Seen in children between 8 – 9 years of age, during eruption of permanent canines.
- Its typical features are:
  - *Flaring of the lateral incisors.*
  - *Maxillary midline diastema*

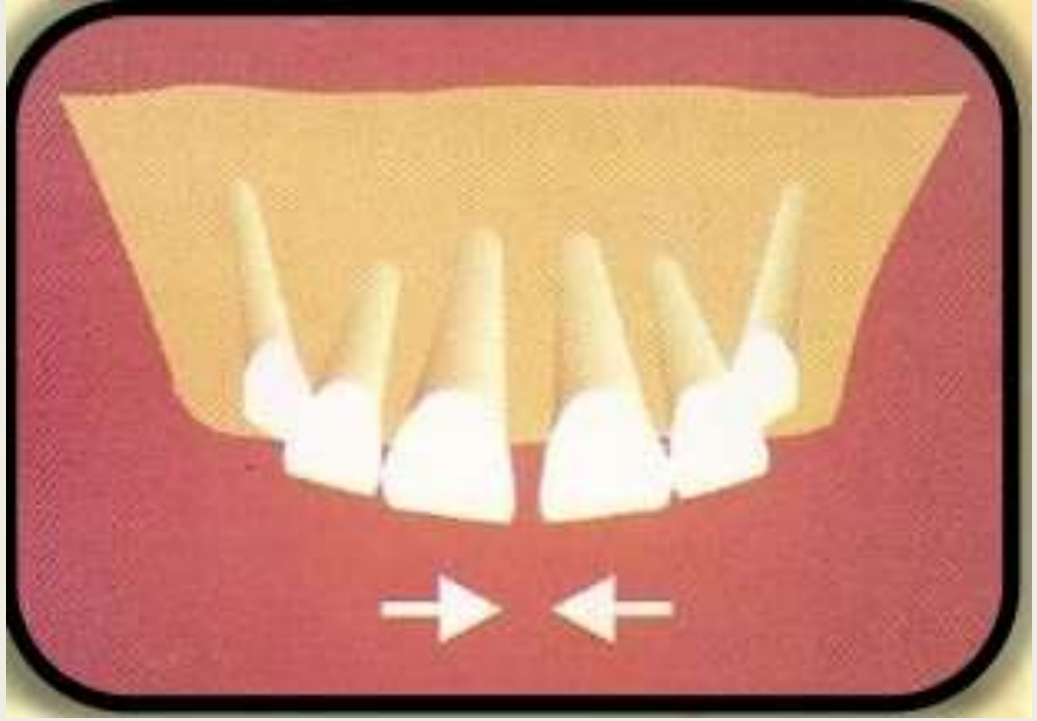
- How it develops?
  - Crowns of canines in young jaws impinge on developing lateral incisor roots, thus driving the roots medially and causing the crowns to flare laterally.
  - The roots of the central incisors are also forced together, thus causing a maxillary midline diastema

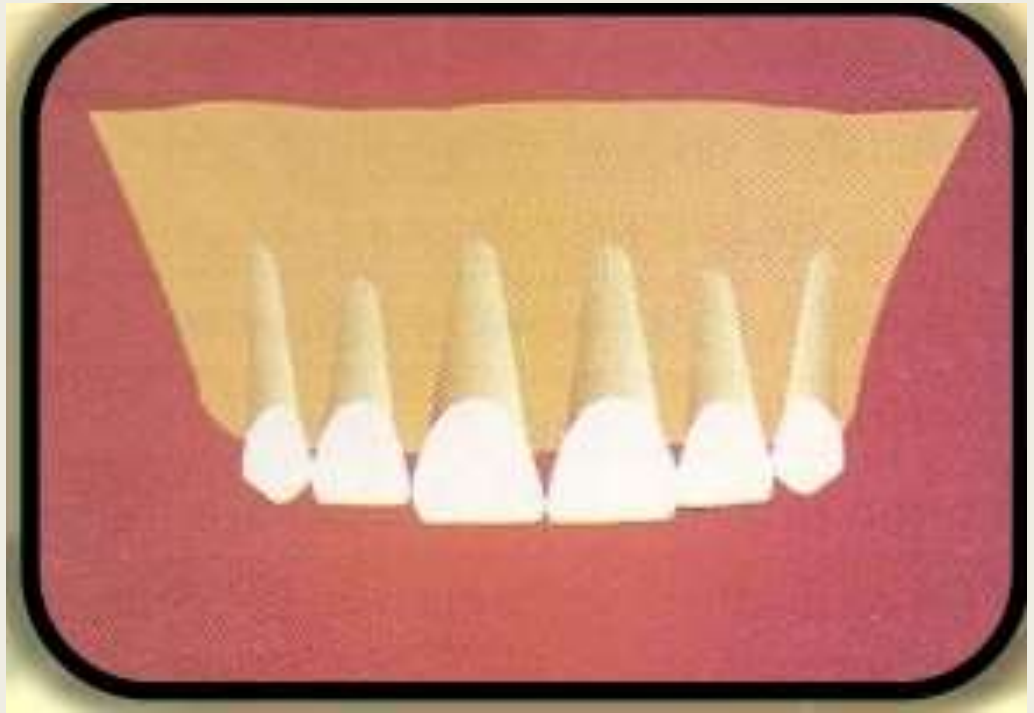




- With the eruption of the canines, the impingement from the roots shift incisally thus driving the incisor crowns medially, resulting in closure of the diastema as well as the correction of the flared lateral incisors.

- Hence this unaesthetic metamorphosis, eventually leads to an aesthetic result.





Clinical significance

- As a guideline, maxillary midline diastema up to 2 mm closes spontaneously.
- Total closure of a median diastema greater than 2 mm is unlikely.
- Any attempt to close the median diastema during ugly duckling stage will be hazardous.
- Apex of the lateral incisors will be damaged.
- Canine may be deflected from its normal path of eruption.

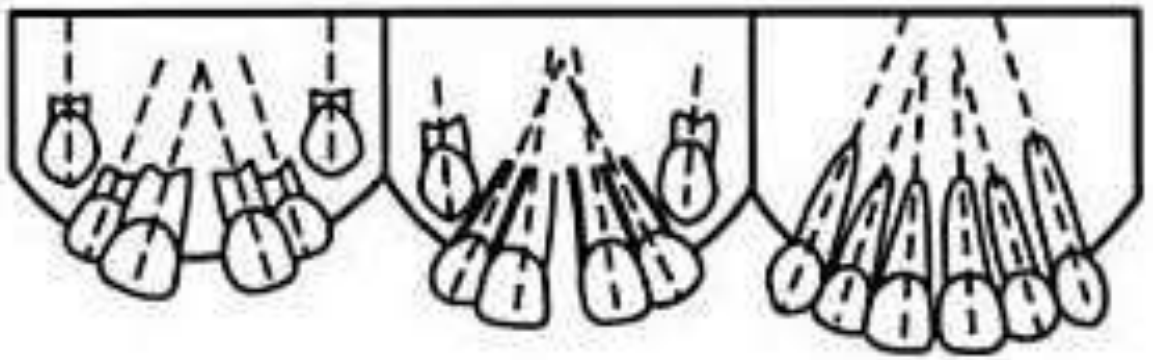
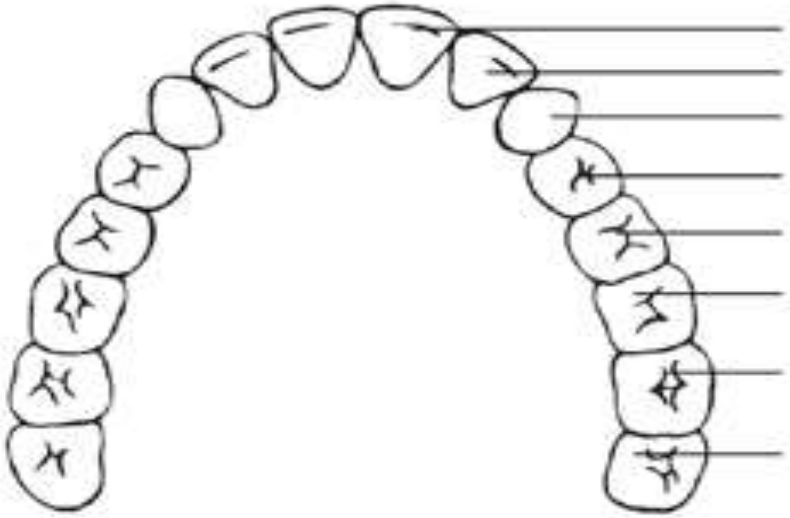


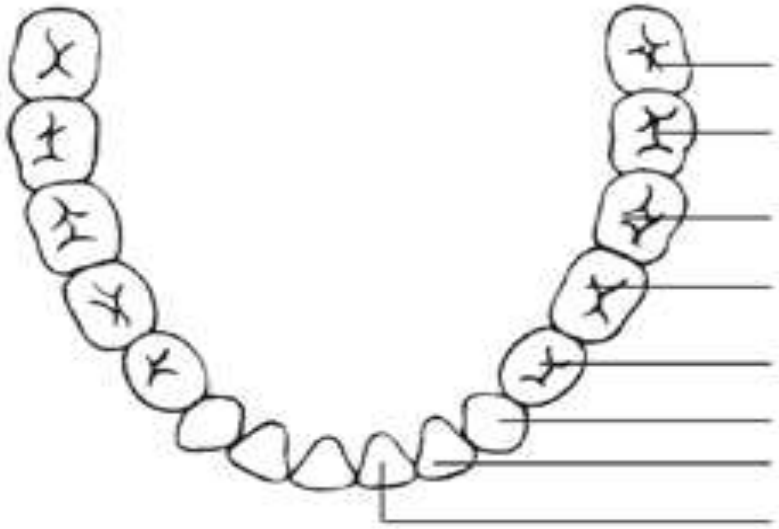
Fig. 5.10. Ugly duckling stage.

- Favourable occlusion in this period is largely dependent on:
  - *Favourable eruption sequence.*
  - *Satisfactory tooth size to available space ratio.*
  - *Attainment of normal molar relation with minimum diminution of space available for the bicuspids.*

Permanent Dentition Period



Upper Teeth	Erupt
Central incisor	7–8 yrs.
Lateral incisor	8–9 yrs.
Canine (cuspid)	11–12 yrs.
First premolar (first bicuspid)	10–11 yrs.
Second premolar (second bicuspid)	10–12 yrs.
First molar	6–7 yrs.
Second molar	12–13 yrs.
Third molar (wisdom tooth)	17–21 yrs.



Lower Teeth	Erupt
Third molar (wisdom tooth)	17–21 yrs.
Second molar	11–13 yrs.
First molar	6–7 yrs.
Second premolar (second bicuspid)	11–12 yrs.
First premolar (first bicuspid)	10–12 yrs.
Canine (cuspid)	9–10 yrs.
Lateral incisor	7–8 yrs.
Central incisor	6–7 yrs.

- This period is marked by the eruption of the four permanent second molars
- The entire permanent dentition is formed within the jaws after birth except for the cups of the first molar which are formed before Birth.
- Sequence of Eruption:
- **Maxillary Arch:** 1^{st} molar, CI, LI, 1^{st} premolar ,2^{nd} premolar, canine, 2^{nd} molar, 3^{rd} molar.
- **Mandibular Arch:** 1^{st} molar, CI, LI, canine, 1^{st} premolar, 2^{nd} premolar, 2^{nd} molar, 3^{rd} molar

Eruption Of Permanent Second Molars

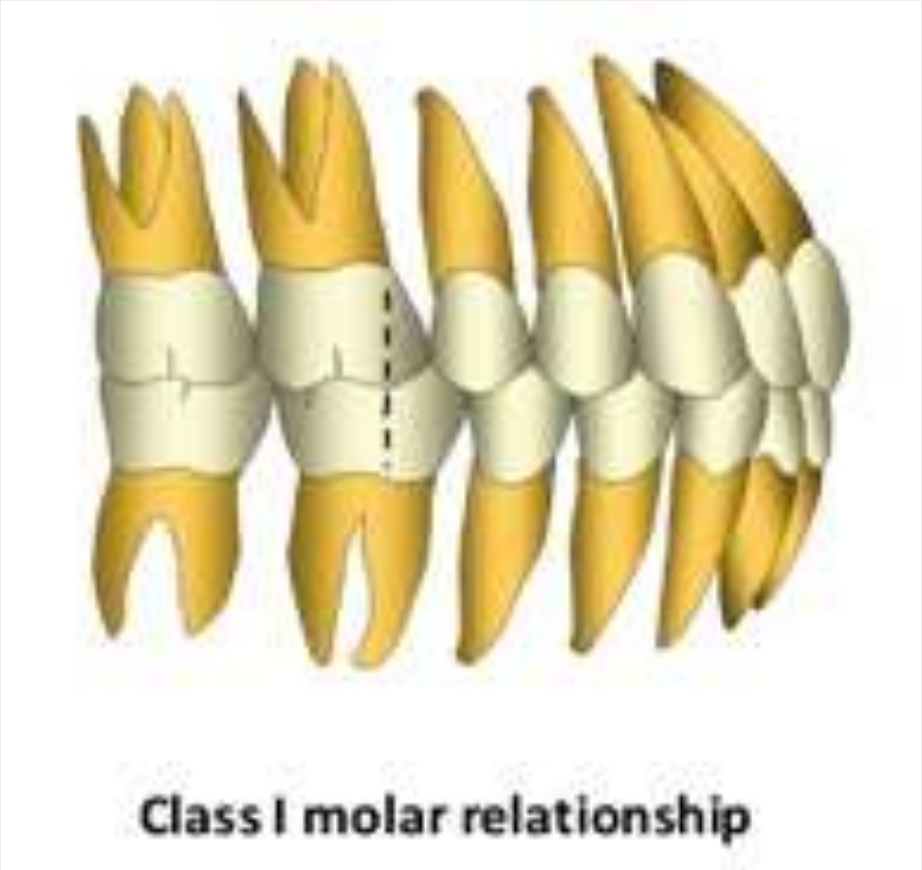
- Before emergence, second molars are oriented in a mesial & lingual direction.
- Teeth- formed palatally, guided into occlusion by *Cone Funnel mechanism ,* upper palatal cusps (cone) slides into the lower occlusal fossa (funnel).
- Arch length is reduced by mesial eruptive forces.
- Thereby, crowding if present is accentuated.
- At approximately 13 years of age all permanent teeth except third molars are fully erupted.

Key’s Of Occlusion:

- Permanent dentition after establishing itself is governed by various factors.
- These were underlined as ANDREW’s SIX KEYS OF OCCLUSION.
- Put forward by Dr.Lawrence F. Andrews in 1972
- He hypothesized that the presence of these features is necessary for an ideal occlusion.

Key I Molar Relationship

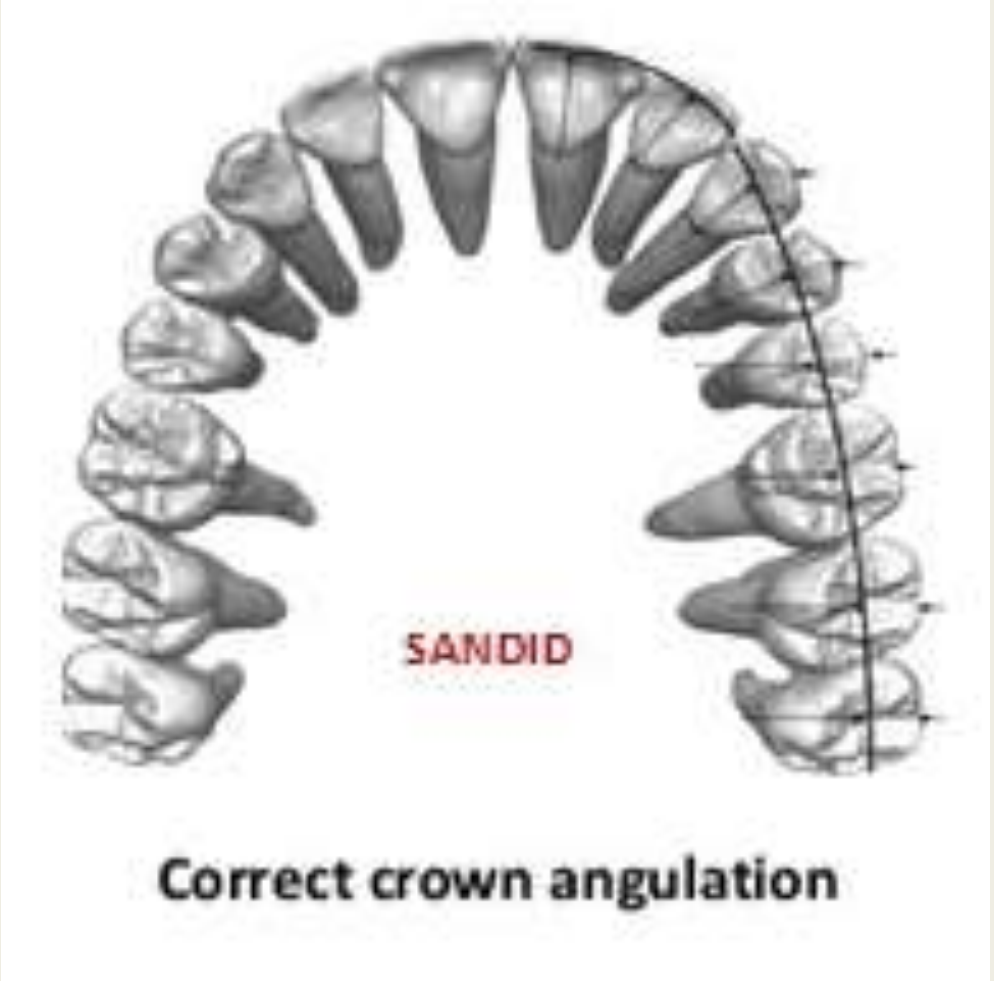
- MB cusp of the max 1st molar falls into the mesiobuccal groove of the mandibular 1st molar and that the distal surface of the DB cusp of the upper first permanent molar should make contact and occlude with mesial surface of the MB cusp of the lower second molar



Class I molar relationship

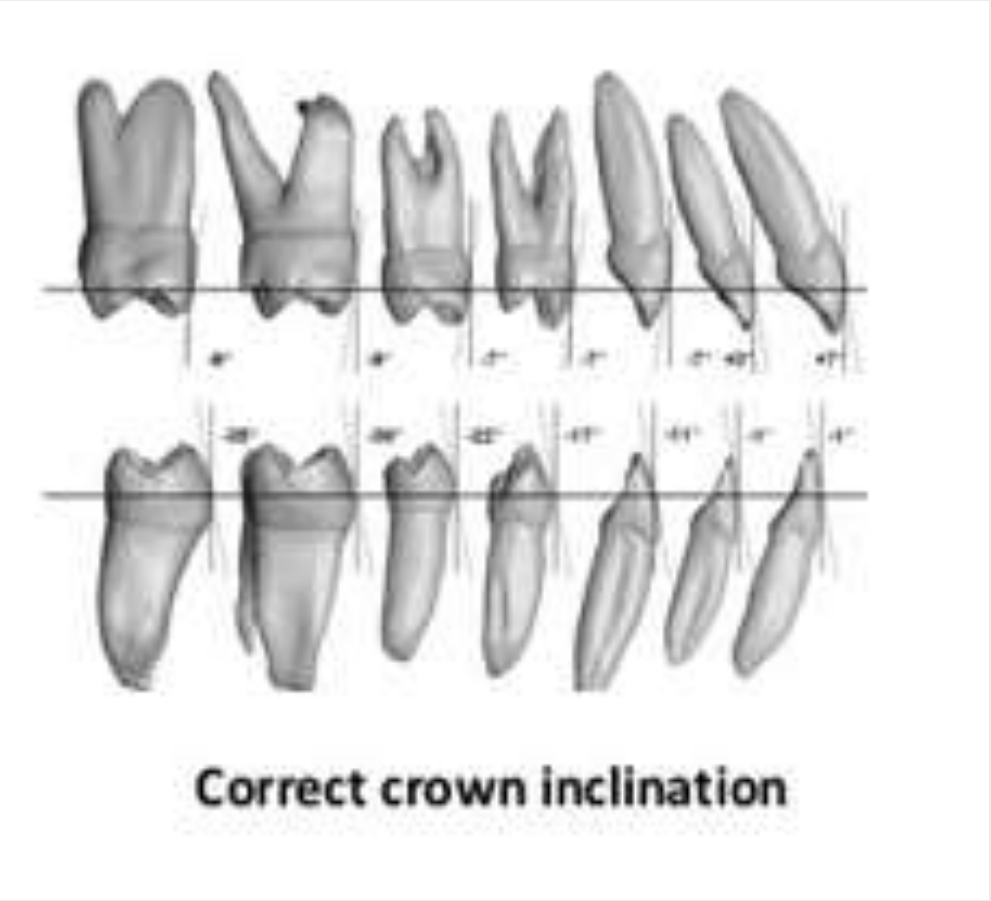
Keyll Crown Angulation

- The gingival portion of the long axis of all the crowns must be distal than the incisal portion.
- The angulation of the facial axis of every clinical crown should be positive.



Key III Crown Inclination .

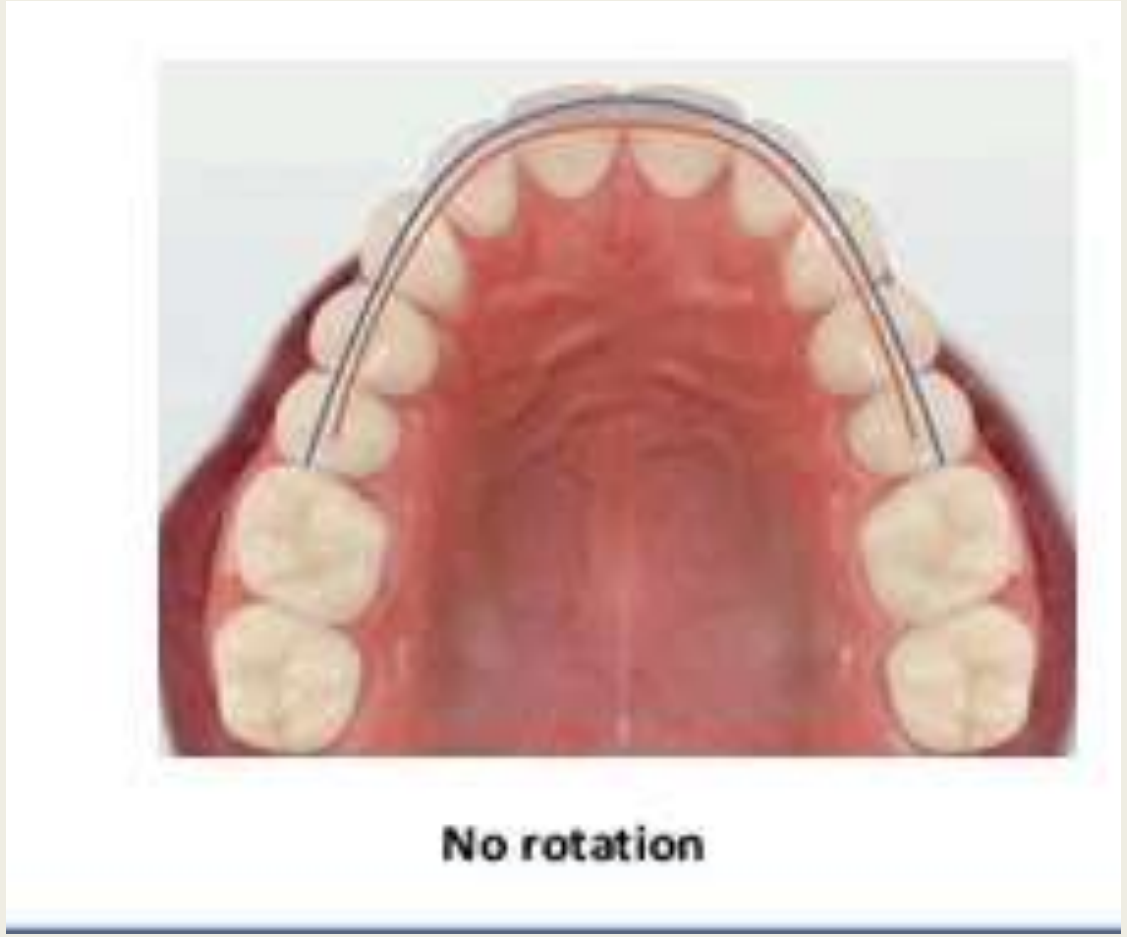
- Cervical area of crown is lingually placed then it is called as positive crown inclination and if it is more buccally then it is called as negative crown inclination.
- Maxillary incisors: Positive.
- Mandibular inciors and maxillary and mandibular posteriors: Negative



Correct crown inclination

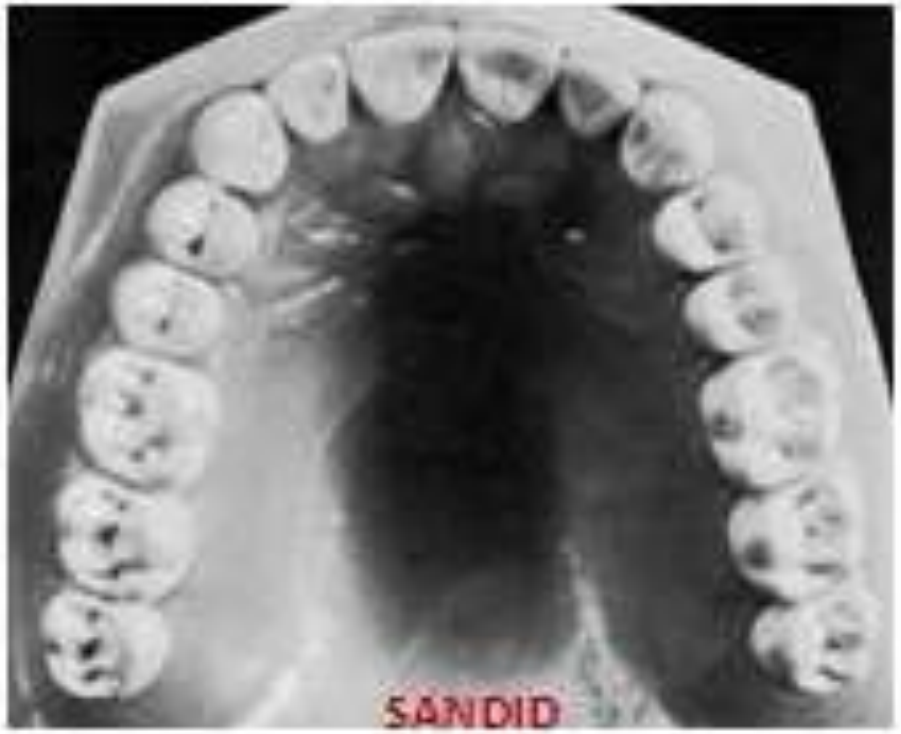
Key IV – Rotations

- The fourth key to normal occlusion is that the teeth should be free of undesirable rotations.



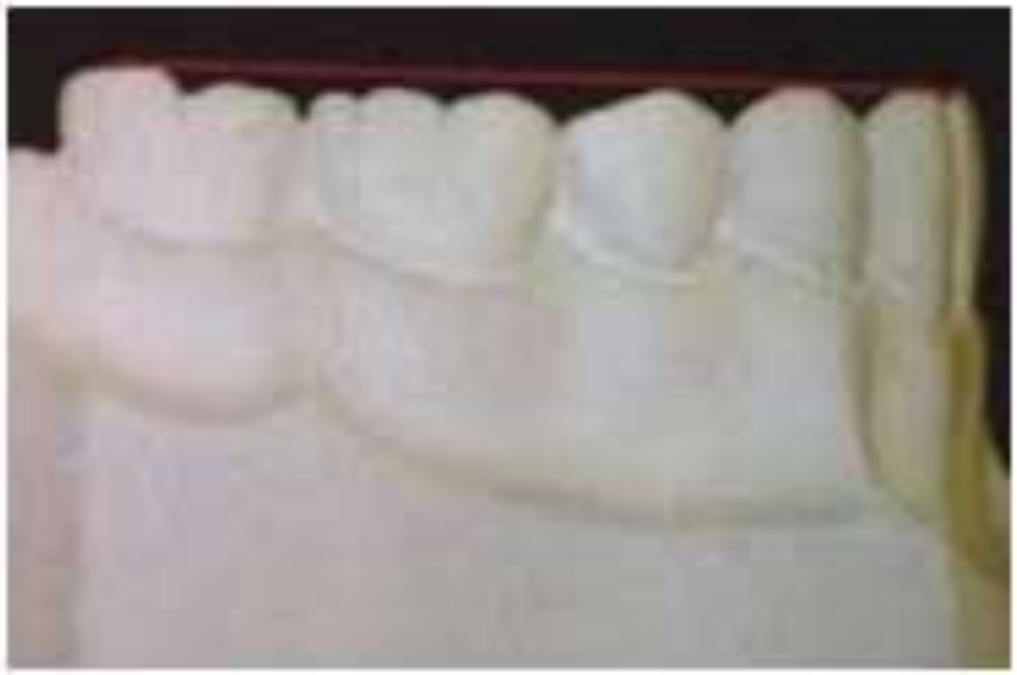
Key V – Tight Contacts

- Contact points should be tight (no spaces).
- In absence of abnormalities such as genuine tooth size discrepancies, contact point should be tight.



Key VI – Curve of Spee

- The curve of Spee should have no more than a slight arch.(Not exceeding 1.5mm)
- Intercuspation of teeth is best when the plane of occlusion is relatively flat.
- A deep curve of spee results in a more contained area for the upper teeth, making normal occlusion impossible.



Flat to slight curve of spee

Key VII – Correct Tooth Size Or The Bolton's Ratio

- **Bennett** and **McLaughlin** in **1993** gave seventh key to normal occlusion. i.e. the upper and lower tooth size should be correct.

Changes in Permanent Occlusion

- Arch dimensional Changes:
- Arch length decreases to a surprising amount during the late adolescent period.
- Fish found that Mandibular arch perimeter decreases by 5.0mm between 9-16 years whereas maxillary arch perimeter decreased by about half the amount as it was in the mandibular arch.

Occlusal Changes:

- Both overjet and overbite decreases throughout the second decade of life.
- It is due to greater forward growth of the mandible and the eruption of permanent molars.
- Overbite decreases up to the age of 18 years by 0.5mm
- Overjet decreases by 0.7mm between 12 and 20 years of age.
- The alveolar process may grow in height beyond 16 years of age.

Self Correcting Anomalies

Stage of development	Self-correcting anomaly	Correction will occur due to
Gum pads	(a) Retrognathic mandible	(a) Differential and forward growth of the mandible
	(b) Anterior open bite	(b) Eruption of primary incisors
	(c) Infantile swallow	(c) Weaning of liquid to solid food
Primary dentition	(a) Anterior deep bite	(a) Eruption of primary molars, attrition of incisal edges, and forward and downward growth of mandible
	(b) Straight terminal plane occlusion	(b) Early mesial shift
	(c) Primary spacing	(c) Eruption of permanent teeth
Mixed dentition	(a) Mandibular anterior crowding	(a) Secondary spacing, intercanine width increase, tongue pressure
	(b) Ugly duckling stage	(b) Maxillary canine eruption
	(c) End-on relation of first permanent molar	(c) Late mesial shift
Permanent dentition	Overjet and overbite	Eruption of all permanent teeth and differential growth of mandible

FACTORS AFFECTING THE DEVELOPMENT OF OCCLUSION

- ***GENERAL FACTORS:***
- Skeletal factors: The position, size and relation of bone in which the tooth develops.
- Muscle factors: The form and function of the muscle which surround the teeth.
- Dental Factors: The size of the dentition in relation to the size of the jaws.
- The position and relationship of the teeth within the bone.

- The path followed by the tooth to reach the mucous membrane before eruption.
- The forces which guide its course after eruption- Buccinator Mechanism.
- The forces which start to operate when the tooth makes contact with its opponent.

- ***LOCAL FACTORS***:

- Aberrant developmental position of teeth
- The presence of supernumerary teeth.
- Hypodontia-The congenital absence of certain teeth.
- The effect of certain Habits.
- Localized soft tissues anomalies –the labial frenum.

Clinical Significance:

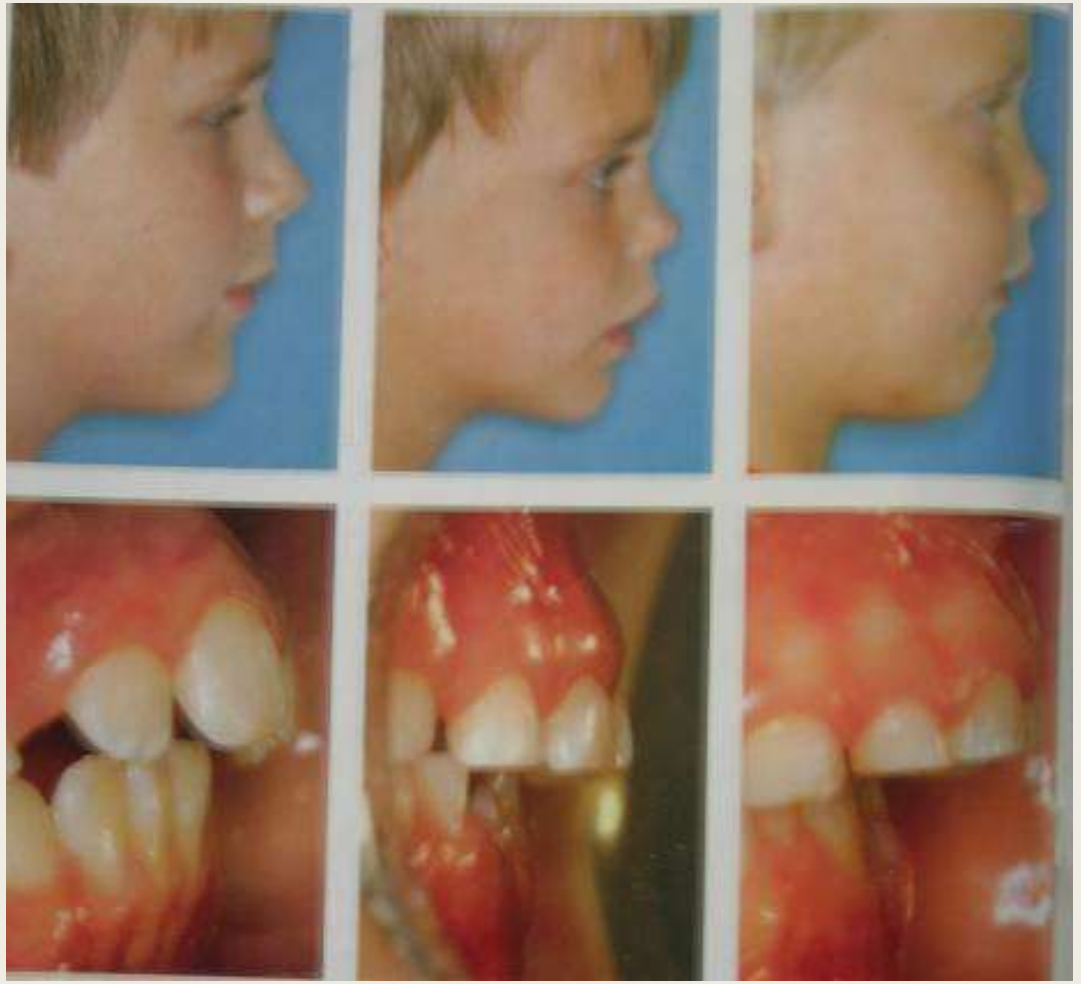
- No longer can a dentist look at a child's mouth, observe a space deficiency and then attribute it to the premature loss of teeth or prolonged retention of teeth. In the past, local "causes" were stressed but today we know the importance of general factors in etiology of malocclusion along with the local causes.
- Knowledge of the contribution of genetic and environmental causes of malocclusion obligates clinicians to differentiate between patients whose malocclusions are primarily of genetic origin from patients whose malocclusions are primarily of environmental origin.

- Abnormal morphologic structures in the face and dentition that have a high degree of heritability require different treatment approaches from those structures that are influenced primarily by environmental factors.
- For most patients the differentiation between genetic and local environmental factors is of great importance when choosing the appropriate treatment and retention plans.

Heredity

- Heredity has for long been attributed as one of the causes of malocclusion.
- Another reason attributed for genetically determined malocclusion is the racial, ethical & regional inter-mixture.
- Number of human traits that are influenced by the genes include (according to Lundstrom):
  i. *Tooth size*
  ii. *Arch dimension*
  iii. *crowding/spacing*
  iv. *Abnormalities of tooth shape*
  v. *Abnormalities of tooth number*
  vi. *Overjet*
  vii. *Inter-arch variations*
  viii. *Frenum*

- Genuine Class II malocclusion in three brothers



Congenital

- They are malformations seen at the time of birth
- - Its causes can be broadly classified as

1. General congenital factors
2. Local congenital factors

- General congenital factors

i. Abnormal state of mother during pregnancy
ii. Malnutrition
iii. Endocrinopathies
iv. Infectious disease
v. Metabolic and nutritional disturbances
vi. Accidents during pregnancy and child birth
vii. Intra-uterine pressure
viii. Accidental traumatization of the fetus by external forces

- Local congenital factors

i. Abnormalities of jaw development due to intra-uterine position
ii. Clefts of the face and palate
iii. Macro and microglossia
iv. Cleidocranial dysostosis

- The following are some of the congenital conditions frequently encountered by a dentist.

i. Clefts of the lip and palate

ii. Congenital syphilis

iii. Maternal rubella infections

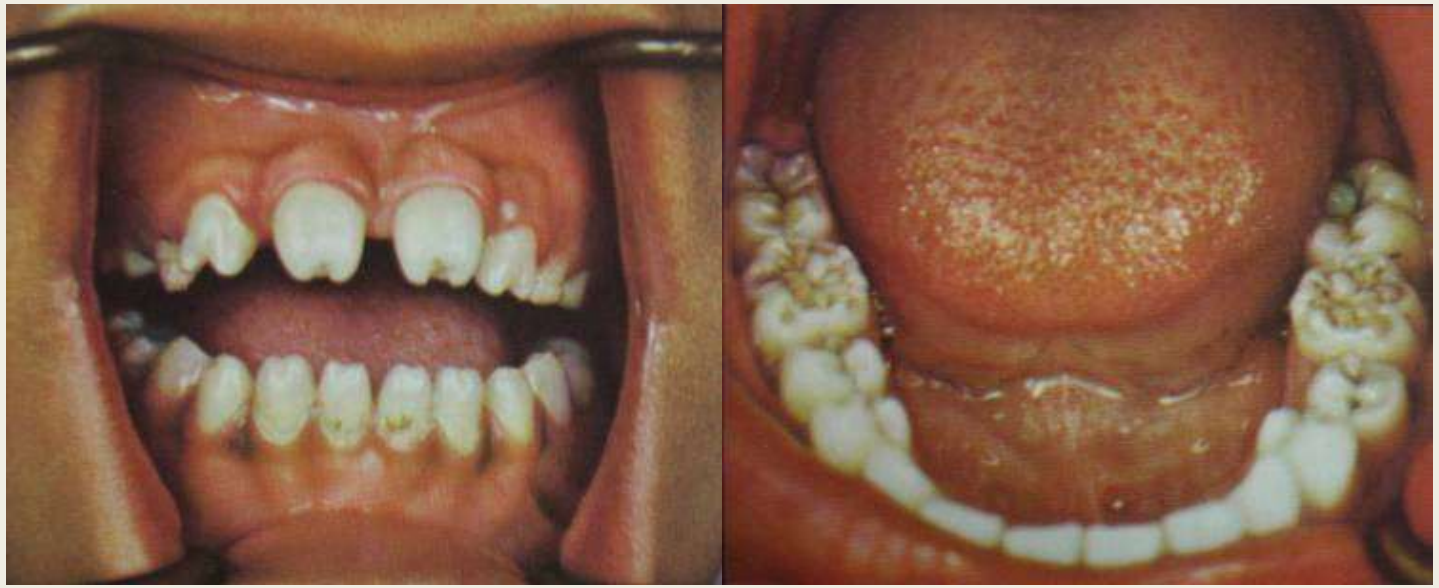
iv. Cerebral palsy

CLEFTS OF THE LIP AND PALATE

- Cleft Palate can be defined as a furrow in the palatal vault or Breach in continuity of palate.
- Most commonly seen congenital deformity at the time of birth.
- Both dental & skeletal components affected
- Such patients exhibit following
  - *Missing Teeth*
  - *Mobile teeth*
  - *Rotations*
  - *Cross bite*
  - *Impacted teeth*
  - *Supernumerary teeth, etc.*

CONGENITAL SYPHILIS

- The child exhibits one or more of the following features:
  - *Hutchinson's incisors*
  - *Mulberry molars*
  - *Enamel defect*
  - *Extensive dental decay*
  - *The maxilla may be smaller in size relative to the mandible*
  - *Anterior cross bite*



MATERNAL RUBELLA INFECTIONS

- Maternal rubella infections during pregnancy show some features:
  - *Dental hypoplasia*
  - *Retarded eruption of teeth*
  - *Extensive caries*

CLEIDODOCRANIAL DYSOSTOSIS

- This is a congenital condition characterized by unilateral or bilateral, partial or complete absence of the clavicle.
- The patient may exhibit the following features
  - *Maxillary retrusion & possible Mandibular protrusion*
  - *Over retained deciduous teeth & retarded eruption of permanent teeth*
  - *Presence of supernumerary teeth*
  - *Presence of short & thin roots*

ENVIRONMENT

- **PRE-NATAL FACTORS**
- Fetus is well protected against injuries & nutritional deficiency during pregnancy
- But there are certain factors, presence of which can result in abnormal growth of oro-facial region thereby predisposing to malocclusion
- Pressure against rapidly growing areas leads to distortion
- Arm pressed against the face- maxillary deficiency
- Head flexed against the chest- Mandibular deficiency.
- Decreased amniotic fluid- small mandible
- Cleft palate results due to upward displacement of tongue.
- Growth catches-up when pressure is released except when cartilage is affected- Stickler syndrome
- Thalidomide – gross congenital deformities including cleft

Teratogens Affecting Dentofacial Development

Teratogens	*Effect*
Aminopterin	Anencephaly
Aspirin	Cleft lip and palate
Cigarette smoke (hypoxia)	Cleft lip and palate
Cytomegalovirus	Microcephaly, hydrocephaly, microphthalmia
Dilantin	Cleft lip and palate
Ethyl alcohol	Central mid-face deficiency
6-Mercaptopurine	Cleft palate
13-cis Retinoic acid (Accutane)	Retinoic acid syndrome, possibly some cases of hemifacial microsomia, Treacher Collins syndrome
Rubella virus	Microphthalmia, cataracts, deafness
Thalidomide	Malformations similar to hemifacial microsomia, Treacher Collins syndrome
Toxoplasma	Microcephaly, hydrocephaly, microphthalmia
X-radiation	Microcephaly
Valium	Cleft lip and palate
Vitamin D excess	Premature suture closure

POST-NATAL FACTORS

- **Birth injuries**
- Forceps delivery
- TMJ damage
- ANKYLOSIS of TMJ.
- An increased **asymmetric molar occlusion** was observed with traumatic breech delivery.
- A tendency for abnormal dental arch dimension, larger height of the maxilla and greater length of the mandibular arch was observed to occur as a result of forceps delivery.

➢ Palatal grooves and cleft formation:

- A prolonged oro-tracheal intubation of pre term infants is seen to be associated with airway damage, palatal groove formation, defective primary incisors and an acquired cleft palate.

➢ Delayed eruption of primary teeth:

- ***Viscardi*** (1994) found that first primary teeth eruption at the usual chronologic age in healthy premature infants, but eruption may be delayed in premature infants who require a prolonged mechanical ventilation for neonatal illness/or who experience inadequate nutrition

Hormonal

- **Hypopituitarism:**
- Dwarfism
- Delayed eruption of permanent teeth and delayed shedding of primary teeth.
- Crowding due to smaller arch size.
- Mandibular growth more affected than maxilla.

- **Hyperpituitarism:**
- Gigantism- large teeth and jaws.
- Acromegaly- occurs after growth and ossification is complete.
- Lips thick, tongue enlarged, shows scalloping.
- Accelerated condylar growth-large mandible.
- Teeth tipped buccally due to large tongue.

- **Hypothyroidism:**
- Delayed eruption.
- Abnormal resorption pattern.
- Retained deciduous teeth.
- Malposed teeth-deflected from eruption path.
- Gingival disturbances.

- **Hyperthyroidism:**
- Early shedding and irregular eruption.
- Atrophy of alveolar bone.

DIETARY PROBLEMS

- **NUTRITIONAL DEFICIENCY**
- Disturbances in the developmental timetable.
- Poor absorption-hormonal/enzymatic deficiency.
- Rickets, scurvy and beri-beri can produce severe malocclusions.
- Premature loss of teeth/Prolonged retention.
- Abnormal eruptive path.
- Poor tissue health
- **Decreased fluoride intake-** Loss of teeth due to caries---malocclusion.

ABNORMAL PRESSURE HABITS AND FUNCTIONAL ABERRATION

- EQUILIBRIUM THEORY
- If an object is acted upon by a set of forces but remains in the same position, then the forces must be in balance.
- Dentition is in equilibrium.
- Movement occurs when equilibrium is disturbed.

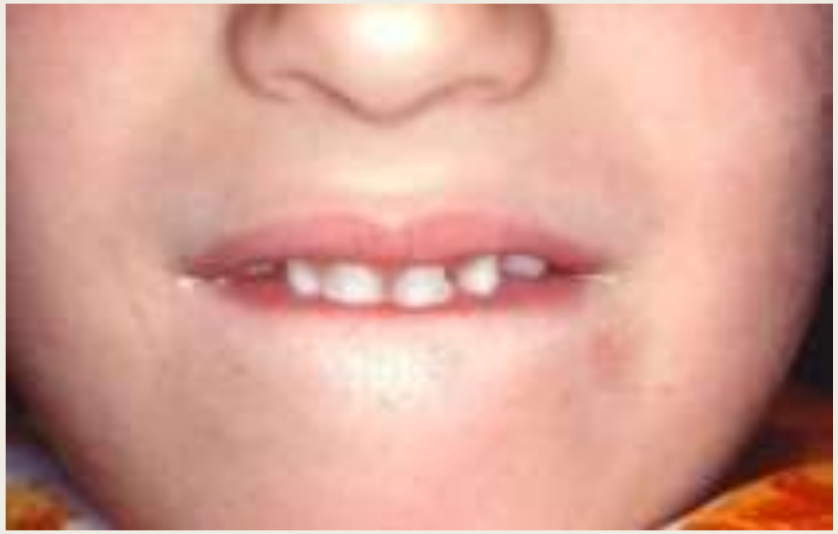
MALOCCLUSION CAUSING HABITS.

- Thumb and finger sucking
- Tongue thrusting &Abnormal swallowing habits
- Lip and nail biting
- Mouth breathing
- Psychogenic habits and bruxism.

Thumb Sucking

- Labial flaring of maxillary anterior teeth
- Lingually collapsed mandibular anterior teeth
- Increased overjet
- Hypotonic upper lip and hyperactive lower lip
- Posterior cross bite due to maxillary arch contraction
- Simple tongue thrust associated with open bite
- Narrow nasal floor and high palatal vault.

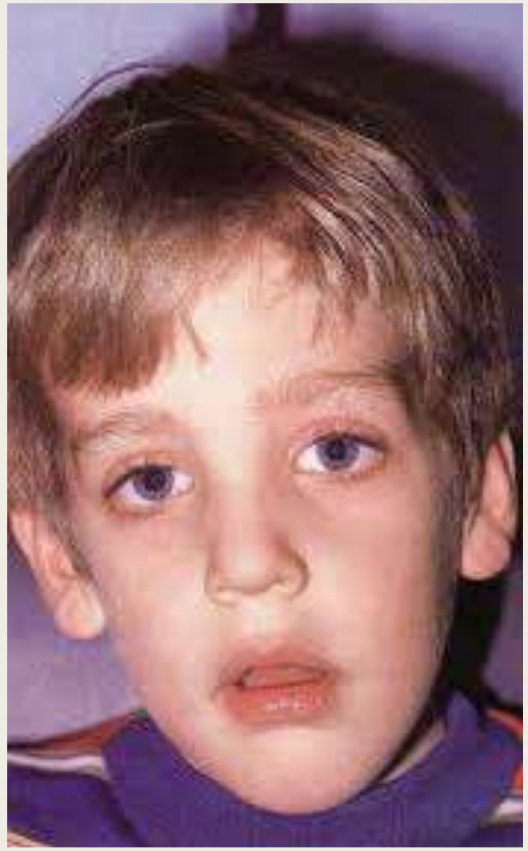
Lip biting.



- Labial placement of maxillary incisors.
- Collapsed lower incisors
- Increased overjet
- Reddened, irritated and chapped area below the vermillion border and is usually seen in the lower lip.
- Can be associated with mentalis habit.

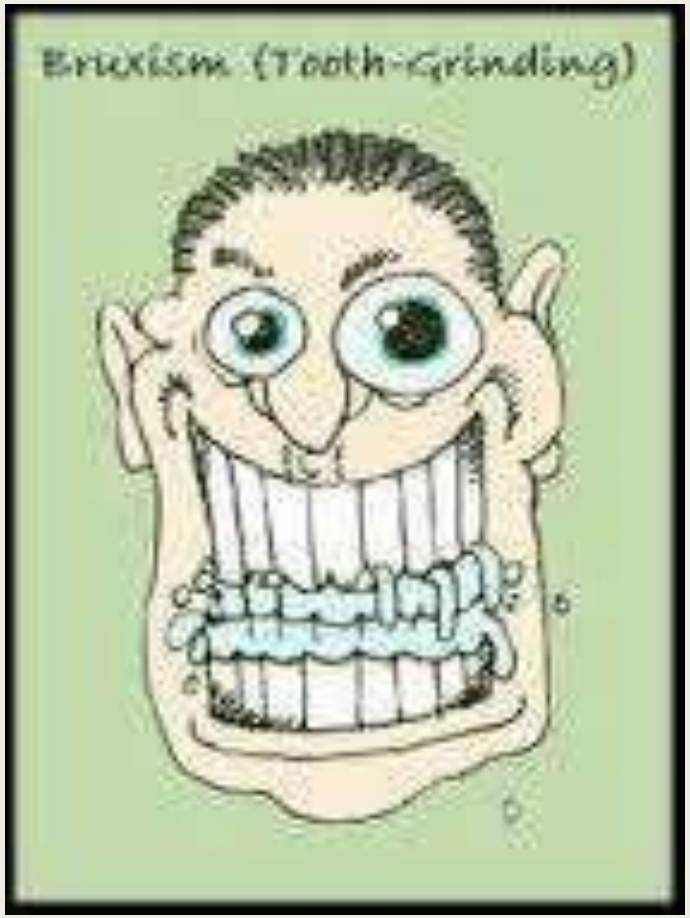
Mouth breathing

- Facial Appearance : *Adenoid Facies*
- Long narrow face, narrow nose and nasal passage.
- Flaccid and short upper lip.
- Doliofacial skeletal pattern.
- Nose tipped superiorly.
- Expressionless face.
- Narrow maxillary arch.
- Labial flaring of maxillary incisors.
- Mouth breathing gingivitis.
- Anterior open bite.
- Increased caries incidence in maxillary anterior teeth.



Bruxism

- Occlusal surfaces are worn out considerably with exposing dentin
- Masticatory muscle soreness
- TMJ pain
- Trauma to the periodontium.



POSTURE

- May accentuate existing malocclusion.
- Role as primary etiological factor to be proved conclusively.
- Frequently suggested that poor posture can lead to malocclusion.
- Stooping with chin on the chest- mandibular retrusion.
- Child resting head on hand or sleeping on arm or fist- possible development of malocclusion.

ACCIDENT OR TRAUMA

- Undiscovered traumatic experiences- significant in malocclusion.
- Eruptive abnormalities.
- Abnormal resorption.
- Loss of vitality.
- Both prenatal trauma & postnatal injuries- Dentofacial deformity.

LOCAL FACTORS

- ***ANOMALIES IN NUMBER OF TEETH:***
- In order to achieve good occlusion, normal number of teeth should be present.
- Presence of extra teeth or absence of one or more teeth predisposes to malocclusion.
- Heredity plays a strong part in anomalies in number of teeth.

- ***SUPERNUMERARY TEETH:***
- Teeth that are extra to the normal complement are termed *supernumerary teeth*.
- These teeth have abnormal morphology and do not resemble normal teeth.
- Extra teeth that resemble normal teeth are called *supplemental teeth.*
- They result from disturbances during the initiation and proliferation stages of dental development.
- Usually develop from a 3rd tooth bud arising from the dental lamina near the permanent tooth bud.

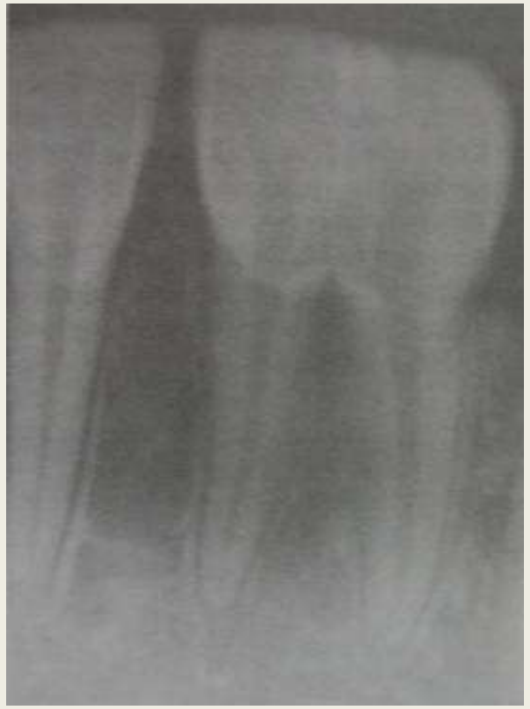
- ***Supernumerary teeth can cause:***
- Non-eruption of adjacent teeth
- Delay the eruption of adjacent teeth
- Deflect the erupting teeth into abnormal locations
- Crowding in the dental arches.

- ***ANOMALIES OF TOOTH SIZE:***
- There should be harmony between the tooth size and the arch length, and also between the maxillary and mandibular tooth size, in order to have normal occlusion.
- An increase in size of teeth results in crowding while, smaller sized teeth predispose to spacing.
- Anomalies of size of teeth can be of 2 types:
  - *Microdontia*
  - *Macrodontia*

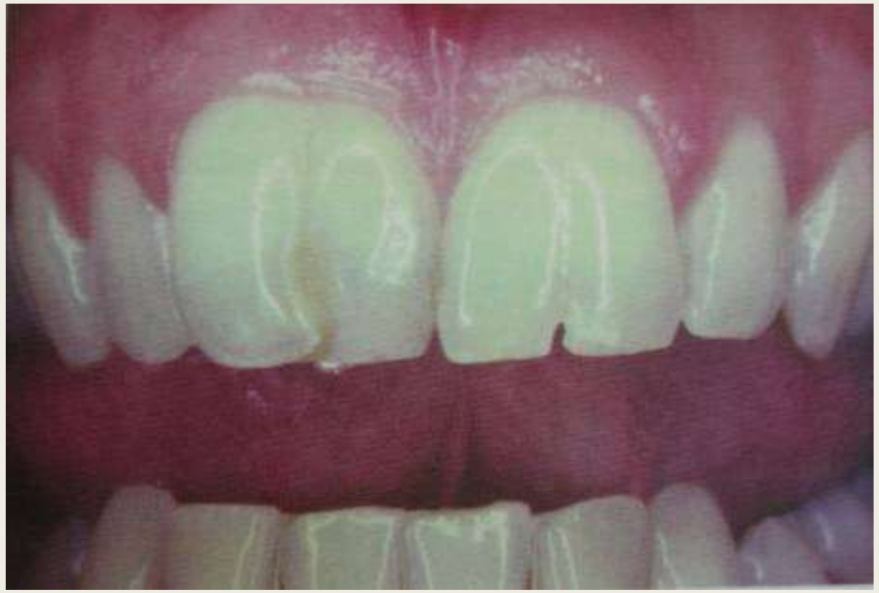
- ***ANOMALIES OF TOOTH SHAPE:***
- Anomalies of tooth size and shape are often interrelated. Abnormally shaped teeth predispose to malocclusion.
- Anomalies of tooth shape include:
- The presence of *peg shaped* maxillary lateral incisors is often accompanied by spacing and migration of teeth.
- *Abnormally large cingulum on maxillary incisors-*
  - *Prevent establishment of normal overbite and overjet.*

  The involved tooth is usually in labio-version due to the forces of occlusion.
- *Additional lingual cusp of mandibular 2nd premolars-*
  - *Increase the mesio-distal dimension of tooth*

- ***Fusion-***
- Fused teeth arise through the union of 2 normally separated tooth germs.

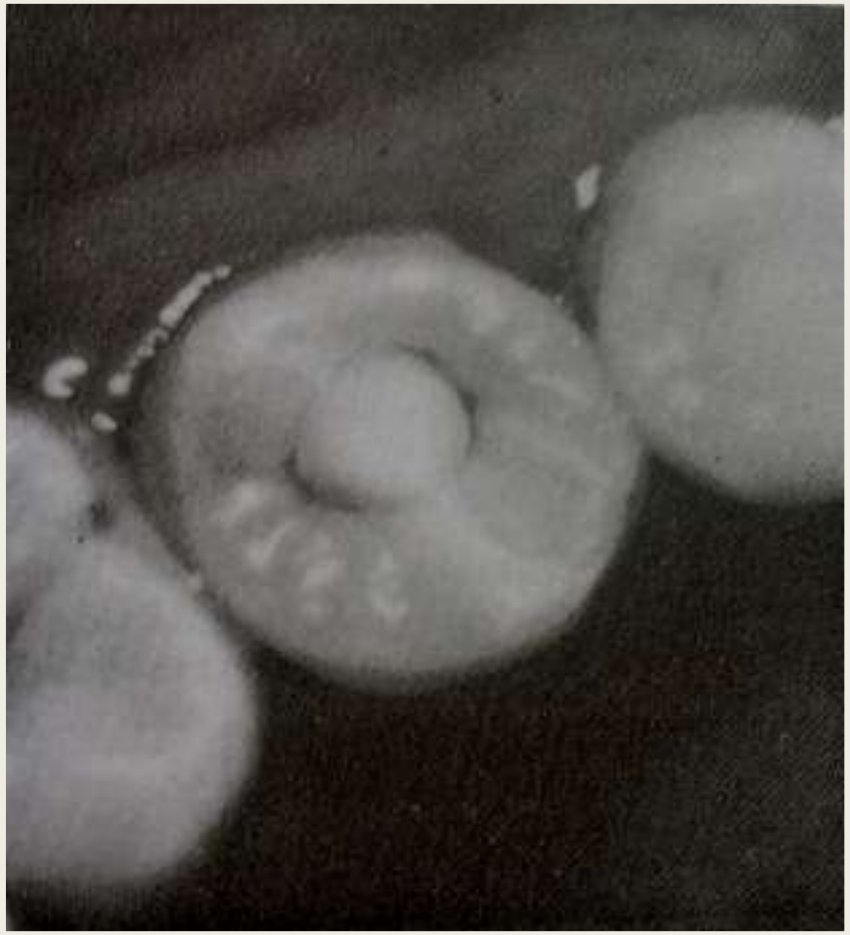


- ***Gemination-***
- Results from attempt at division of single tooth germ

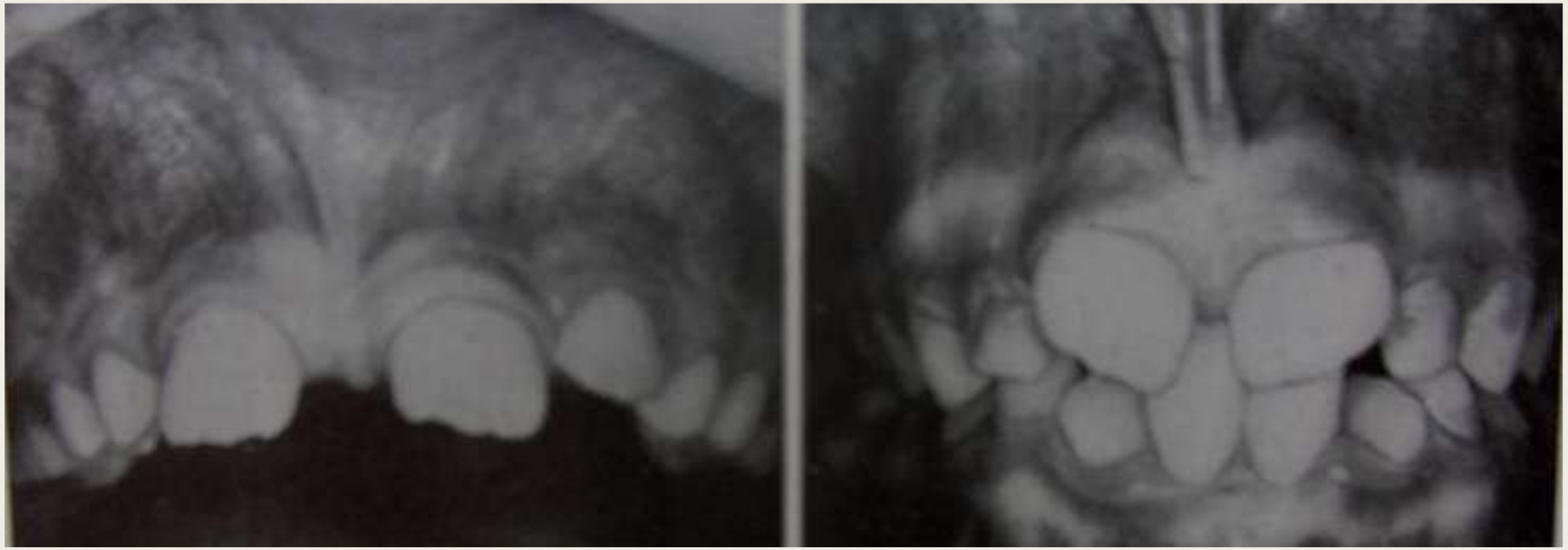


- ***Dilaceration –***
- Dilacerated tooth often fails to erupt to proper level and can thus interfere with normal occlusion.
- They may also complicate extraction of teeth and may interfere with tooth movement and alignment.

- *Dens evaginatus* –
- It may result in incomplete eruption, displacement of teeth and may interfere with normal occlusion.



- ***ABNORMAL LABIAL FRENUM POSITION:***
- Shows spacing between the maxillary central incisors



PREMATURE LOSS OF DECIDUOUS TEETH

- ***Premature loss can occur due to:***
  - *Caries*
  - *Trauma*
  - *Endocrinal disturbances like hyperthyroidism*
  - *Metabolic disturbances like hypophosphatasia*
- When a primary tooth is lost before the permanent successor has started to erupt, bone may reform atop the permanent tooth, delaying its eruption.
- When its eruption is delayed, more time is available for other teeth to drift into space that would have been occupied by the permanent tooth.

PROLONGED RETENTION OF DECIDUOUS TEETH

- Can occur because of :-
  - *Absence of underlying permanent teeth*
  - *Endocrinal disturbances such as hypothyroidism and hypopituitarism*
  - *Ankylosed deciduous teeth that fail to resorb*
  - *Malposition of erupting permanent teeth*
- Prolonged retention of deciduous anteriors usually results in lingual or palatal eruption of their permanent successor
- Prolonged retention of buccal teeth results in eruption of the permanent teeth either buccally or lingually or may remain impacted within the jaws.

DELAYED ERUPTION OF PERMANENT TEETH

- Probable causes for delayed eruption of permanent teeth :-

i. Early loss of a primary tooth might cause formation of a bony crypt over the succedaneous tooth.

ii. Presence of supernumerary tooth can block the eruption of permanent tooth.

iii. Presence of a heavy mucosal barrier can prevent the

iv. permanent tooth from emerging into the oral cavity.

v. Presence of odontomas or other cysts and tumors might prevent the permanent tooth from erupting.

vi. Presence of deciduous root fragments that have not resorbed may block the erupting permanent tooth.

vii. Presence of ankylosed deciduous teeth may cause delay in eruption of permanent teeth.

viii. Congenital absence of permanent teeth

ABNORMAL ERUPTIVE PATH:

- *Some causes of abnormal eruptive pathway are:*

i. In cases of arch length deficiency, deflection of the erupting tooth may be merely an adaptive response to the condition present.

ii. Presence of supernumerary teeth, retained deciduous teeth, root fragments, bony barrier or mucosal barrier may result in abnormal eruptive pathway.

iii. Traumatic displacement of tooth buds–

    i. A deciduous tooth may be driven into the alveolar process, and though it may erupt later, it may displace he developing successor in an abnormal direction.

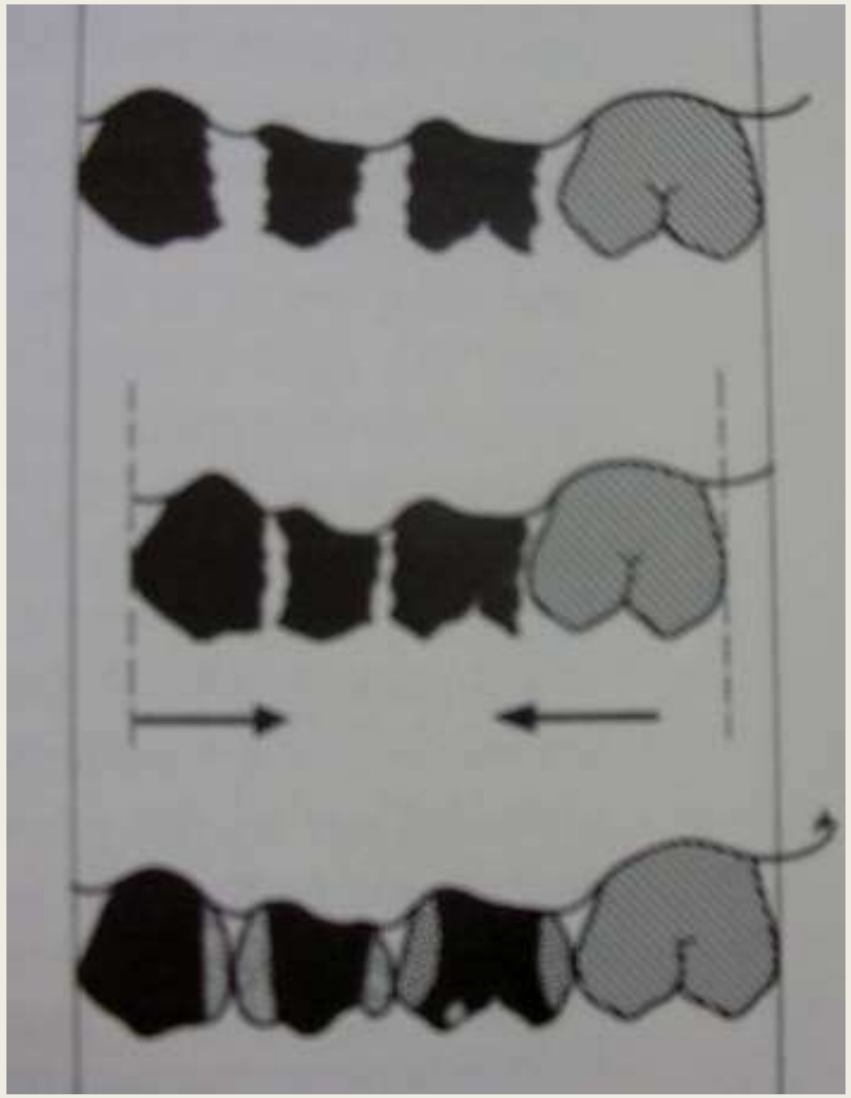
iv. Coronal cysts can also cause abnormal eruptive paths

ANKYLOSIS

- Ankylosis is encountered relatively frequently during the 6 –12 year age period.
- It may result due to an injury of some sort as a result of which a part of the periodontal membrane is perforated and a bony “bridge” forms joining the lamina dura and cementum.
- The “bridge” need not be large to stop the normal eruptive force of a tooth.
- The most commonly affected tooth is mandibular 2nd deciduous molar.
- Accidents or trauma, infections, certain congenital disorders like cleidocranial dysostosis predispose to ankylosis of teeth.

DENTAL CARIES

- Caries can lead to premature loss of deciduous or permanent teeth thereby causing migration of contiguous teeth, abnormal axial inclination and supra-eruption of opposing teeth.
- Proximal caries that has not been restored can cause migration of adjacent teeth into the space leading to a reduction in arch length.
- A substantial reduction in arch length can be expected if several adjacent teeth involved by proximal caries are left un-restored.



IMPROPER DENTAL RESTORATIONS

- Malocclusion can be caused due to improper dental restorations.
- *Under-contoured proximal restorations* result in loss of arch length due to drifting of adjacent teeth to occupy the space.
- *Over-contoured proximal restorations* might bulge into the space to be occupied by a succedaneous tooth and result in a reduction in this space.
- Overhang or poor proximal contacts may predispose to periodontal breakdown around these teeth.
- Premature contacts or an over-contoured occlusal restoration can cause a functional shift of the mandible during jaw closure, whereas, under- contoured occlusal restorations can lead to the supra-eruption of the opposing teeth.

CONCLUSION

- Occlusion, good or bad is the result of an intricate and complicated synthesis of genetics and environmental relationship at work throughout the early developmental stages of childhood.
- Understanding the concepts has thus, got far reaching implications in diagnosis , treatment planning and prognosis of malocclusion.

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