

**Developing Class III malocclusion Classification, Clinical and radiographic Integrates and early intervention - A Review**

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**Abstract**

Dento-facial deformity due to the discrepancy in the growth of maxilla and mandible with mandibular prognathism leads to the class III malocclusion. Class III jaw relation developing in young children may be due the restricted growth of upper jaw due to anterior cross bite, due to functional shift of mandible anteriorly, or may be due to true skeletal discrepancy in growth of jaws and it is difficult to diagnose in developing child. Due to challenging nature of class III malocclusion, early intervention and treatment does not solve all the problems and success depends upon the residual growth of maxilla and mandible. However, based on set of favourable and unfavourable factors, the decision of interceptive treatment could be taken in order to reduce the severity of further orthodontic and surgical treatment. So, this paper gives an idea of developing class III malocclusion/ jaw relation various favourable

and unfavourable factors based on which it could be decided whether to go for interceptive treatment or wait till the completion of growth. Also, various options of appliance that are used for early intervention like inclined plane, active Hawley’s appliance, 2/4or 2/6 appliance, face mask, reverse twin block, FR-III, chin cap etc. based on scientific evidence.

**Keywords:** Dento-facial, Pseudo Class, CCD,

**Introduction**

Angle’s class III malocclusion means that the mandibular first molars is anteriorly placed in relation to the maxillary first molar <sup>(1)</sup>. It is a phenotypic description however; it does not explain about the skeletal bases. Class III problems may arise due to deficient growth of maxilla in the downward and forward direction and more forward growth or reduced downward growth of mandible <sup>(5)</sup>. Hence, a hypodivergent growth pattern accentuates the Class III problem due to more growth

rotation of the mandible in the upward and forward direction, while a vertical growth pattern alleviates it due to downward and backward rotation, provided that excessive facial height does not become the problem instead<sup>(5)</sup>. Class III jaw relation may be associated with certain syndromes (Downs syndrome CCD, etc.) due to maxillary hypoplasia.

Class III discrepancy should be diagnosed and classified according to its etiology and treated with appropriate surgery, including if necessary not only mandibular but also maxillary surgery. Nonsurgical management of Class III malocclusion remains a challenge. However, the extent and burden of severity in adolescence could be reduced by early diagnosis and intervention<sup>6</sup>.

#### **Classification of Class III malocclusion**

C. H. Tweed further classified Class III malocclusions into; Category A; Also known as Pseudo Class III malocclusion in which there is normal mandible and, Category B; Also known as skeletal class III malocclusion, in which, there is either mandibular prognathism or underdevelopment of maxilla.<sup>(2)</sup>

Park and Balk 2001, Angle's class III malocclusion can be categorized into three types based on the status of maxilla. Type A has a normal maxilla, Type B has a hyperplastic maxilla and Type C has hypoplastic maxilla<sup>(40)</sup>.

In 1915 Dewey's gave the three modification of Angle's class III, In Type I dental arches are well formed and teeth are in normal alignment in respective arches when viewed individually, edge to edge bite when attempt is made to approximate dental arches and it appears that the mandibular arch has moved forward bodily. In Type II, mandibular incisors are crowded and in lingual related to maxillary incisors.

Type III – maxillary teeth are crowded due to the underdeveloped maxillary arch however mandibular arch is well aligned and developed<sup>(6)</sup>.

Moyer's class III syndrome mesiocclusion, prenatal occlusion and it is characterized by mandibular prognathism and / or maxillary deficiency, with a class III molar relationship, Mandibular incisors labially placed to maxillary incisors and most frequently, it is deep seated skeletal dysplasia, although may be functional class III<sup>(7)</sup>.

Skeletal classification by Salzmann in 1950 proposed three criteria for class III jaw relation:

a). Mandible in mesial relation to maxilla. b). Obtuse gonion angle and c). Prognathic profile<sup>(8)</sup>.

Discriminant analysis: On the basis of wits appraisal, a severity of class III can be labelled as Red: wits appraisal >12mm required orthogenetic surgery,

Green: wits appraisal <4mm, can be camouflaged by orthodontic tooth movement

Yellow: wits appraisal is 4-12mm, it require further analysis before making a decision and can be added in treatment part<sup>(9)</sup>

#### **Prevalence of Malocclusion**

Existing literature regarding the global prevalence of class III malocclusion has shown its prevalence varies greatly among and within different races, ethnic groups, and geographic studied region. Globally, prevalence of class III malocclusion varies from 0 to 26.7%<sup>(10)</sup> Prevalence ranges from 8.3%-9.1% in Americans<sup>11</sup>, Caucasians between 3% and 5%<sup>12-18</sup> from 2% to 6% in European populations<sup>(11)</sup> Class III malocclusion is more prevalent in white population in United Kingdom and Scandinavia and is about 3%–5%, and about 6% in Sweden<sup>(19,10)</sup>. Israeli Arabs had 1.3% and Iranians about 15.2% prevalence of class III malocclusion<sup>(10)</sup>. African countries had prevalence rate of 4.59%<sup>(10)</sup>. Prevalence of

class III malocclusion is more in Hispanic population as compared to African and Caucasian population groups. In India the prevalence ranges from 0-4.76% (1.19%)<sup>(54)</sup>.

**Etiology of Class III malocclusion**

Class III malocclusion has multiple etiological factors that results in contortion of normal development of dento-facial structures rather than acts as pathology and is due the interaction between the various environmental and genetic factors<sup>(20-22)</sup>. Mandibular growth is majorly influenced by the hereditary<sup>(22-26)</sup>. Habsburg Jaw in European Royalty, a well-known example of familial inheritance of the skeletal class III malocclusion caused by mandibular prognathism, recurred over generations<sup>(27,28)</sup>. The type of inheritance of class III malocclusion is yet not clear whether, it follows autosomal recessive or autosomal dominant type of pattern<sup>(29,30)</sup>

The various environmental factors that act as etiological factors of developing class III malocclusion are, wrong postural habits that change the position of mandibular condyle in the fossa pathologically which is expressed as protruded mandible. Factors like growth hormone stimulus , habits (prolonged suckling , atypical swallowing , resting tongue habits etc.), airway pathology (nasal obstruction , mouth breathing , functional mandibular shift, altered shape and size of pharynx due to macroglossia, tonsillitis and adenoids), hormonal disturbance and / or imbalance (gigantism , pituitary adenomas , early exfoliation of primary teeth etc.), congenital defects (cleft lip and palate either isolated or in combination), muscle dysfunction<sup>(31-36)</sup>.

**Integrates of Class III malocclusion**

In class III malocclusion there is 3-dimensional Facio-skeletal imbalances maxilla-mandibular growth pattern which is compensated by the growth of dento-alveolar and soft tissues<sup>(37)</sup>. Class III malocclusion develops due

to maxillary deficiency or mandibular excess or both<sup>(38-42)</sup>.

The various skeletal features that are commonly associated with class III malocclusion causes anterior positioning of the glenoid fossa that in turn positions the mandible in protruded position. Commonly found skeletal changes include, short anterior (N-S) and posterior (S-Ba) cranial base, narrow saddle angle (N-S-Ar angle), large Gonial angle. Facial pattern in Class III malocclusion at early age has tendency to worsen with time along with the growth as revealed from dental and skeletal ingredients<sup>(43,44,45)</sup>

**Treatment modalities of Developing Class III malocclusion**

It is very difficult to decide whether to intercept/treat or wait for developing class III malocclusion. Time is most crucial factor for successful results of early intervention of class III malocclusion. In literature, it has been seen that for more orthopaedic benefits, treatment should be started before 10 years of age<sup>(46-49)</sup>. However, some studies conclude that age has little effect on the treatment response<sup>(50,51)</sup> Main goal of early intervention is to provide favourable conditions for the dental and skeletal growth. So, interceptive treatment of class III malocclusion should provide favourable results i.e., without any harm to oral tissues and have beneficial effects if further orthodontic or surgical treatment is carried out. Turpin gave a set of factors that help in deciding whether to intervene developing class III malocclusion or not that has been reviewed by Campbell<sup>(46,52)</sup>. Those factors have been categorized into positive and negative factors.

| Positive factors                      | Negative factors             |
|---------------------------------------|------------------------------|
| 1. Convergent facial type             | 1. Divergent facial type     |
| 2. Anteriorposterior functional shift | 2. No antero-posterior shift |

|  |                                  |
|--|----------------------------------|
| 3.Symmetrical Condylar growth          | 3.Asymmetrical Condylar growth   |
| 4. Young subject with remaining growth | 4.Patients with completed growth |
| 5.Mild Skeletal disharmony             | 5.Severe skeletal disharmony     |
| 6.No familial prognathism              | 6.Established familial pattern   |
| 7.Good facial aesthetic                | 7.Poor facial aesthetic          |

Patients with negative characteristics treatment should be delayed until cessation of growth and patients with positive characteristics early intervention should be carried out. Instead of early intervention, the patients with positive characteristics should be informed about the further treatment surgical or orthodontic that may be carried out later on.

**Cephalometric Predictors**

Certain cephalometric parameters that helps whether the class III malocclusion can be camouflaged after maxillary and mandibular evaluation. These factors are as

1. ANB angle  $< -2^{\circ}$  to  $-3^{\circ}$
2. Wits appraisal (from -2mm to -6mm are subjects for non-surgical treatment, from -6mm to -9mm are subjects for compromised orthodontic results)
3. Patients in which maxilla-mandibular differential and gonial angle lies in normal range <sup>(53)</sup>

Evaluate need to optimize facial aesthetic both clinically and Radio graphically is important because this may help to recognize type of class III malocclusion that can be treated in mixed dentition and also in deciding the best interceptive approach. <sup>(53)</sup>

In deciduous dentition most commonly condition present is anterior cross bite that predicts developing class III malocclusion. In case of mixed dentition class III malocclusion is of three types: <sup>(54,55)</sup>

1. Dental due to imprecise inclination of upper and lower incisors.
2. Pseudo Class III due to “anterior positioning of the mandible as a result of premature dental contacts deflecting mandible anteriorly to allow the patient to achieve full intercuspation.”
3. Skeletal Class III “true skeletal discrepancies are present in the maxilla & / or mandible.”

**Treatment of class III malocclusion with simple dentoalveolar anterior cross-bite**

Class III malocclusion with simple dentoalveolar anterior cross-bite can be intercepted by two types of appliances:

- a). Removable appliances which includes
  - Inclined plane
  - Modified inclined plane
  - Actively Hawley appliances
- b). Fixed appliance which includes
  - 2 by 4 or 6 appliance

**Inclined Plane**

Indicated in following conditions:

- Retro lined maxillary anterior with cross-bite
- Well aligned mandibular anterior teeth
- Average to horizontal growth pattern

Inclined plane is fixed with lower anterior teeth with appropriate inclination of plane which is determined by upper anterior teeth in cross-bite their vertical discrepancy. It takes 3-4 weeks to correct anterior cross-bite <sup>(53)</sup>

Disadvantage: Proclination of lower anterior

**Modified Inclined Plane**

Indicated in conditions

- Maxillary retro clined anterior
- Mandibular proclined anterior

Modified inclined plane is constituted of Hawley’s appliance with inclined plane on lower anteriors

covering incisal 1/3<sup>rd</sup> of teeth, labial bow on lower incisors at cervical region. When patient bites on the anterior bite plane, due to the anterior bite plane the bite raises and proclines upper anteriors. Lingual movement of lower incisors can be carried by labial bow after lingual trimming of acrylic that touches the incisors. It takes 3-4 weeks to correct anterior cross-bite. <sup>(53)</sup>

### **Orthopedics Treatment**

Orthopedics treatment brings about the growth modification and commonly used in cases with skeletal discrepancy. Orthopedics correction can be done by extra-oral appliances (Reverse Pull Headgear) chin cup, functional appliances, protraction face mask, and newly designed bone anchored appliances <sup>(53)</sup>. Study conducted by Nur hat in patients ranging from 11-13years with Maxillary deficiency and draw a conclusion that reverse pull headgear can be successfully used in early treatment of skeletal class III malocclusion developed due to maxillary deficiency.

### **Commonly used functional appliance for skeletal class III malocclusion are**

- A). Protraction Facemask
- B). Frankel Functional Regulator III
- C). Reverse Twin Block Appliance
- D). Chin Cup

### **E). SEC protocol**

Facemask which is an extra-oral orthopaedic appliance, has various clinical applications such as, advancement of maxilla with or without expansion, skeletal or dental anchorage. In a case report by Kapoor P, Kharbanda O.P, a 6-year-old boy with skeletal class III malocclusion due to maxillary deficiency, after clinical and radiographic examination, Petit type of facemask to be given was planned. Occlusal splint was constructed and luted and Petit type face was then delivered. Magnitude and direction of force was adjusted as

300grams per side at 15<sup>0</sup> for 10 months. Frankel Functional regulator III was used as retainer for 1 year. After the treatment, positive overjet and settling of occlusion with refinement of profile was seen. <sup>(56)</sup> Use of FR III is supported by a clinical trial because protraction facemask treatment gets stabilized after 2years. <sup>(57)</sup> The time period of facemask can be reduced by adjuvant rapid maxillary expansion (RME) as RME causes loosening of circum-maxillary sutures and enhances protraction of maxilla <sup>(58-63)</sup>.

Most commonly used appliance for class II malocclusion is Clark's Twin Block. Reverse twin block (RTB) which is variant of traditional twin block (TTB) is used for developing class III malocclusion <sup>(54,65)</sup>. RTB differs from TTB as the planes are reversed with same sloping angle (70<sup>0</sup>). In RTB lower block covers molars and upper block covers deciduous molars or premolars <sup>(61)</sup>. The basic principle of RTB is that it delivers forwardly directing force on maxillary arch and backward and downward force on mandibular arch so that the maxillary anterior growth is enhanced and the mandibular growth is temporarily restricted <sup>(64)</sup>. In a case series of two patients of 11year (case I) and 11year (case II) with concave profile and class III molar relation with anterior reverse overjet, RTB was given in both the cases. Malocclusion was corrected in 6month in case I and in 10months in case II. After a follow-up period of 3years (case I) and 2years (case II) they concluded that for treating developing class III malocclusion, RTB seems to be effective and feasible <sup>(66)</sup>. Chin cap is another extra-oral orthopaedic appliance used in patients with mandibular prognathism and short lower facial height. Chin cap functions on the principle of redirecting and restricting growth of mandible and also remodels mandible <sup>(67)</sup>. It causes mandible to rotate in backward

and downward direction, by virtue of which lower facial

height is also increased <sup>(68)</sup>.

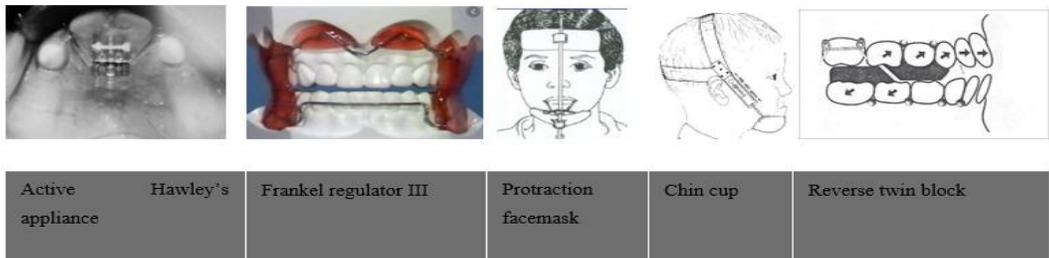


Figure 1:

**SEC III protocol <sup>(69)</sup>**

Consists 2 occlusal Splints (yellow), Class III Elastics (green, attached to hooks), and Chin cup(blue) as shown below;

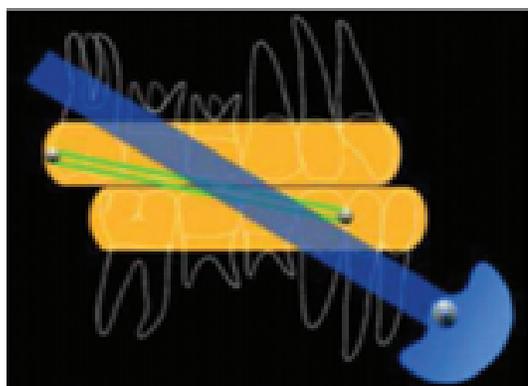


Figure 2: SEC III

The two occlusal splints should cover upper and lower teeth fully from buccal and lingual surfaces and should have flat occlusal surface that helps in enhancing correction of class III malocclusion by removing the cuspal interference as well as lowering the tongue.

Class III elastics are attached to the to the hooks, 2 in upper splint placed distal to last molar and two in lower placed between cuspid and lateral incisor as shown in figure above. Force applied by these elastics should range from 150-750g measure by dontrex. The wearing time for them should be at least 16 h per day and elastics should be changed twice a week <sup>(70)</sup>.

**Side effect**

Extrusion of the upper molars and clockwise rotation of lower jaw.

Chin cup should be used to combat such limitations as the force delivered by chin cup passes through the upper molars and this prevents their extrusion.

One-year duration on an average is needed for SEC III active phase in order to get a positive overjet of at least 2-3mm <sup>(69)</sup>.

However, usually for hyper divergent cases, chances of relapse are more so, for such cases a modified SEC III protocol has been proposed.

**Modified SEC III protocol <sup>(69)</sup>**

This protocol is proposed in order to get greater vertical control. For this purpose, wedge like effect is created by trimming maxillary splint from molar to molar leaving contact at the last molar only.

This wedge effect is enhanced by addition of three hooks, two in maxillary splint between cuspid and lateral incisor, and one in the lower arch in midline. Class III elastics are also attached to these hooks.



Figure 3: Modified SEC III

### Retention and Relapse

Retention following correction of overjet and overbite plays an important role in success of treatment for developing class III malocclusion. From literature, it has been recommended to be from 3 months to 2 years during night <sup>(71,72,73)</sup>. It has been seen that after completion of maxillary protraction, there is 25%-33% probability of relapse of negative overjet <sup>(74,75,76,77)</sup>. The reason for relapse is primarily due to the residual growth of mandible rather than maxillary relapse <sup>(78,79)</sup>. Probability of relapse is high in patients having larger gonial angle (angle between ramus and body of mandible) before the execution of treatment <sup>(74,80,81)</sup>.

| Type of class III based on severity    | GTRV Ratio | Predicts  |
|--|------------|---|
| 1. Mild to Moderate skeletal Class III | 0.33 -0.88 | Can be successfully camouflaged orthodontically                             |
| 2. Borderline Case                     | 0.33-0.38  | Can be successfully treated with facemask or turn out to be a surgical case |
| 3. Severe skeletal class III           | <0.33      | Orthognathic Surgery  |

So, after completion of facemask therapy, cephalometric radiographs are taken for 2-4 years for calculation of GTRV ratio which acts as future predictor of mandibular growth and provides good idea about the need of future surgery <sup>(83)</sup>.

### Conclusion

Early exploration of the various etiological factors of developing class III developing malocclusion such as maxillary hypoplasia or retro-position, mandibular prognathism, anterior cross-bite which may restrict growth of maxilla are important for interceptive management. For interception of developing class III malocclusion, various appliances provide good results and based on the relapse such cases should be followed for longer time period.

In some cases, early interception does not help the patient and they later on need comprehensive

### Growth Treatment Response Vector (GTRV) analysis for growth Prediction of Mandible

A new method for predicting patient's future growth of mandible in class III malocclusion cases after facemask therapy, known as growth treatment response vector (GTRV) analysis. This concept was introduced by Peter Nagan in 2005 <sup>(82)</sup>. GTRV analysis is based on taking serial cephalometric radiographs and after analysis following formula is used to calculate ratio:

Horizontal growth changes of Maxilla

$$\text{GTRV} = \frac{\text{Horizontal growth changes of Maxilla}}{\text{Horizontal growth changes of Mandible}}$$

orthodontic treatment and in some cases surgical correction is needed.

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