

Differential Diagnosis of Skeletal Class III

SUMMARY

Skeletal Class III is a relatively rare malocclusion of the craniofacial complex and the accurate differential diagnosis of its aetiology is necessary so that it may be correctly treated. Differential diagnosis of Class III aetiopathogenesis should distinguish between: a) true skeletal Class III as opposed to pseudo Class III; b) three forms of Skeletal Class III, in which there is either maxillary deficiency only or mandibular excess only or combination of both; and c) skeletal Class III that may be treated with orthodontic treatment alone, as opposed to Class III that is difficult to manage with orthodontic treatment alone and requires combine orthodontic and surgical approach. Differential diagnosis is mainly based on clinical examination and cephalometric analysis. The aim of this paper is to present the basic principles and modes of achieving differential diagnosis in skeletal Class III cases.

Key words: Skeletal Class III malocclusion, Differential Diagnosis

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Introduction

Skeletal Class III malocclusion characterised by a concave facial profile¹ with lower lip protrusion or upper lip retrusion^{2,3} or a combination of the two⁴⁻⁹. The most consistent characteristics of Skeletal Class III malocclusion seems to be the dental Angle's Class III canines and molars, the presence of anterior cross-bite and retroclined mandibular incisors^{10,11} (Figure 1). As for the skeletal structures, these may involve a posterior position of the temporomandibular joint, abnormality in the length or inclination of the cranial base¹² or both and abnormality in the length and position of the maxilla or the mandible or combination of both^{6,11,13-15}. A recent research study concluded that Caucasian Class III patients in early mixed dentition present shorter lower facial height, a concave profile, maxillary retrusion and posterior facial position, as compared to the normal occlusion control group¹⁶. Also, it has been found that the mandibular intermolar width is greater while the maxillary intercanine width is smaller and the tongue posture is significantly lower in Class III subjects and is associated with the dentoalveolar characteristics of the maxilla and mandible¹⁷. The result of a cephalometric study to clarify

the characteristics of cranial-base morphology in adults with skeletal Class III malocclusion showed that greater mandibular length was the first major characteristic in the Class III group, followed by steeper posterior cranial bases, smaller cranial-base angles, more anteriorly positioned basion and more inferiorly positioned sphenoidale¹⁸.



Figure 1. Face profile view and occlusion relationships characterizing a skeletal Class III case

Class III malocclusion is one of the most complex occlusion disorders in regard to diagnosis and treatment, particularly during the late deciduous and mixed dentition periods. As for its treatment, it can a) easy, if it can be treated orthodontically -pseudo Class III cases are included here- and b) difficult or surgical, which requires cooperation of orthodontic and orthognathic surgery expertise¹⁰.

Aetiopathogenesis of Class III malocclusion depends on local/general factors and a complex inheritance mechanism^{15,19,20}. According to Iwakagi, the inheritance mechanism of Class III follows the Mendelian recessive hereditary pattern, while according to Kraus and Wise, the hereditary character may be transmitted by the prevalent or recessive character, depending on patients' race^{21,22}.

Local or general factors include: a) mandibular position disorders; b) premature loss of posterior teeth; c) problems in the eruption of anterior teeth; d) Ricketts respiratory obstruction syndrome; e) clefts; f) hormonal disorders; and g) trauma.

Hereditary factors include dependent multi-gene transmittance and familial occurrence²³. Recessive manner of inheritance concerning Angle Class III is due to the mother in 18% of cases and to the father in 31% of cases¹⁰.

In the general population, incidence of Angle Class III malocclusion is lower, when compared to Angle Classes I and II, and depends on the geographical region. An epidemiological study indicates that Class III incidence around the world ranges from 1% to 26.7%²⁴, while in Greece it occurs in about 1% of the population²⁵. This malocclusion is more frequently encountered in Asian populations and less so among Caucasians, Latin Americans and African populations²⁶. Serious Angle

Class III malocclusion is a rare phenomenon, occurring among less than 0.5% and, mainly, in Asian and African populations²⁷. The incidence of class III malocclusion is reported to be 3% in the Caucasian population, 3.4%.in India 5% in African-American adolescents and about 14% in the Asian population²⁸.

Differential diagnosis of skeletal Class III from pseudo Class III

The differential diagnosis of skeletal Class III from pseudo Class III is initially made with manipulation monitoring the course of the mandible from its maximum depression position to intercuspitation. This mandibular course in skeletal Class III is normal. When there is pseudo Class III, the course of the mandible from maximum depression position to initial occlusive contact is normal. However, as it continues, the mandible slides forward to achieve intercuspitation, which affects the position of the chin and makes it come forward. Another clinical criterion of differential diagnosis for skeletal Class III opposed to pseudo Class III is the patient's ability to bring the incisors into centric occlusion contact²⁹⁻³¹ (Figure 2). If the patient cannot achieve this position despite trying, then there is a skeletal problem, while if the patient achieves the position, this is an indication that the case is a pseudo Class III. Lingual or labial tipping of mandibular incisors is indicative, since in skeletal Class III cases, mandibular incisors tip lingually, whereas in pseudo Class III they present normal or labial tipping^{20,32-34}. Furthermore, in cases where there is mandibular protrusion with pseudo Class III, there may appear oblique enamel abrasion on the lingual aspect of the upper incisor edge as well as retroclined upper incisors^{35,36}.



Figure 2. Class III patient who can bring the canines into centric occlusion contact. This ability is an indication of a pseudo Class III case.

Differential diagnosis of skeletal Class III from pseudo Class III is accurately performed using cephalometric analysis of two lateral cephalometric radiographs taken simultaneously; in this case, one is taken when the mandible is at rest and the other at intercuspitation³⁷ (Figure 3). If the case is one of skeletal

Class III, the anteroposterior position of the mandible in the two radiographs does not change, whereas, in the pseudo Class III, the mandible is in a more anterior position at intercuspitation than the one observed at the resting mandible radiograph⁶. Mandibular protrusion leading to mandibular 'pseudoprotrusion' and pseudo



Figure 3. Confirmation of differential diagnosis of skeletal Class III and pseudo Class III, based on cephalometric analysis of two concurrent lateral cephalometric radiographs, of which one is taken with the mandible at rest, while the other in the intercuspidation position

Class III is usually due to premature loss of maxillary deciduous incisors, to delayed maxillary permanent incisors eruption, to early eruption of mandibular permanent incisors, to retroalveolar maxilla position caused by early premolar and molar contacts or even by deciduous canines, if they have not been subjected to natural abrasion³⁸.

Differential diagnosis of the three forms of skeletal Class III

Class III malocclusions can be caused by either the upper jaw being too small, the lower jaw being too large, or a combination of both³⁹. Ellis and McNamara found that 65–67% of all class III malocclusions were characterized by maxillary deficiency⁴⁰. According to Proffitt, 40% of skeletal Class III cases are caused by the maxillary position and size, 42% by the mandibular position and size and 18% by both²⁷ (Figure 4). Differential diagnosis of these three skeletal Class III types is mainly based on lateral cephalometric radiographs.

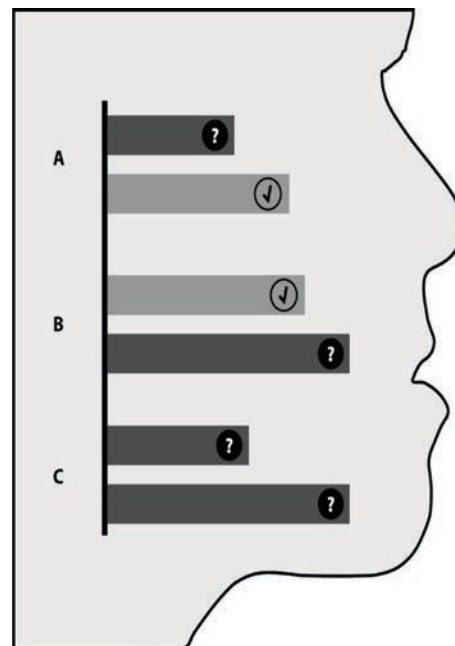


Figure 4. Skeletal Class III may be caused A) either by the maxilla; B) or by the mandible; C) or by both jaws

An aid for the differential diagnosis of these three skeletal Class III types is the procedure of isolating different facial components on patient photographs, as described by Proffitt. Using a profile photograph of a Class III patient, the middle part of the face is isolated with a card. Creating a new facial image is an aid to assess mandibular position in relation to the cranium. Then, on the same photograph, the mandible is isolated, so as to assess the position of the middle face and the maxilla. This way, the position of each jaw individually to the cranium can be assessed as can the relative contribution of various facial components and the jaws to the overall discrepancy of skeletal Class III.

During clinical examination, differential diagnosis of the three skeletal Class III types - which might be caused only by the maxilla or only by the mandible or by both jaws - can be achieved by filling the upper lip with soft wax or a cotton swab (Figure 5). This means that when the maxilla is in a posterior position, the facial profile is balanced. If there is intense protrusion of the mid- and lower face, then the problem is most likely caused by mandibular excess. If the face improves but does not balance, then the problem is more likely caused by maxillary deficiency as well as mandibular excess⁴¹.



Figure 5. A skeletal Class III patient, whose face improved following the placement of a cotton swab behind the upper lip; however, no balance was achieved, and therefore, it was inferred that the retrusion of the maxilla and the protrusion of the mandible are to blame

During the cephalometric study to assess the antero-posterior position of the maxilla, the S-N-A angle⁴², the Po-Or/Na-A angle -the angle of the maxillary position, defined by the Frankfurt horizontal and the Na-A level- and the distance of point A from the McNamara line -i.e., the vertical line through point Na- are used⁴³.

To assess the length of the maxilla, we measure the anterior cranial base (CC-Na) and the maxillary length (Ans-Pns)⁴⁴. When the maxilla is responsible for skeletal Class III, it is in a posterior position and/or short, which results in its retrusion. This is a case of maxillary residual growth on the sagittal and, often, the transverse dimension as well. This is usually encountered in Asian facial types, in the Binder syndrome (maxillonasal dysplasia)⁴⁵, in premature lesion of the nasal cartilage, in nasal dysplasia, in clefts, or in multiple agenesis (maxillary atresia). Furthermore, it is encountered in cases of achondroplasia, which is a hereditary anomaly accompanied by shortening of the extremities with a normal sized torso, forehead protrusion and normal mandibular position, with an image of Class III due to the small anterior cranial basis and the nasal cavity.

In order to assess mandibular anteroposterior position, we usually use the S-N-B angle and the Po-Or/Na-Pog facial angle. To assess the anteroposterior position of the mandibular ramus we use the Xi-Ptv angle. To assess the anteroposterior temporomandibular joint position, we usually measure the Po-Ptv distance, the cranial deviation angle, i.e., Po-Or/Na-Ba, and the N-S-Ba angle.

To assess mandibular body length, we use the Xi-Pm distance or the Go-Gn distance^{46,47}. When the mandible is responsible for skeletal Class III, it is protruded and/or long.

Skeletal Class III is a hereditary dysplasia and may be caused by a small cranial base with normal maxilla, by a normal cranial base accompanied by a mandible that is too long, by maxillary deficiency and retrusion, by a normal mandible that is, however, protruding in relation to the face, by maxillary retrusion combined with mandibular protrusion and by anterior mandibular rotation. Skeletal Class III could also be caused by a large mentum, which is often hereditary and results in a concave Class III profile¹⁰.

Differential diagnosis of surgical and non-surgical Class III

Differential diagnosis between skeletal surgical and non-surgical Class III is based on clinical examination and assessment of the abnormality, as well as on the analysis of lateral cephalometric radiographs.

When it comes to orthodontic skeletal Class III treatment, there are some limitations, when: 1. The severity of the skeletal problem exceeds the possibilities offered by orthodontic treatment, e.g., in cases of intense facial disharmony 2. Facial aesthetics remains unattractive even after orthodontic treatment; 3. The patient's age does not allow for growth exploitation; 4. orthodontic treatment alone cannot compensate for skeletal problems; 5. Functional occlusion cannot achieve through orthodontic or prosthetic works; 6. The duration of the orthodontic treatment is an inhibitory factor for the patient; 7.

Comparative analysis of facial structure heredity is not favourable^{48,49}.

When analysing lateral cephalometric radiographs for the purpose of performing differential diagnosis between surgical and non-surgical skeletal Class III cases, the first thin one needs to focus on is these five cephalometric measurements, which are called alert signals for Class III cases. These are the cranial deviation angle; the position of the mandibular ramus; the Po position; the facial angle and the mandibular body length¹⁰ (Figure 6).

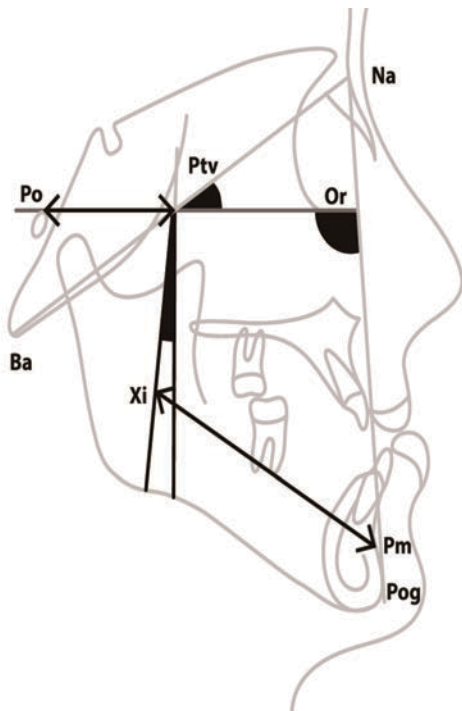


Figure 6. The five cephalometric measurements which are the alert signs for the presence of surgical Class III malocclusion

Furthermore, typical skeletal Class III growth, as shown by the cephalometric analysis should also be taken into account. If it is found reduced cranial base growth by one third, as compared to normal growth; excessive mandibular body growth, by more than one sixth of its length, as compared to normal length; prolonged growth up to the age of 21 years; increased growth of the condylar region, as compared to the region of the coronoid process -the more posterior this is, the worse the prognosis-, that is means that treatment requires not only orthodontics but also orthognathic surgery^{14,34,50}.

For growing patients, the study of growth based on at least two lateral cephalometric radiographs taken at least with a one-year interval between them, is necessary. During normal growth, the cranial base (Na-Ba) and the facial axis growth on the chin level are equal to 2.6mm per year. In skeletal Classes III (surgical and non-surgical) cranial base growth is usually reduced, in the order of 1mm per year. When facial axis growth on the chin level is normal (2.6mm/year), then orthodontic-orthopaedic treatment during a growth period is quite likely to be successful. In surgical skeletal Classes III, besides the reduced cranial base growth, the facial axis increment on the level of the chin is excessive (3.5mm/year) and this means that after the orthodontic-orthopaedic treatment during the period of growth the situation is highly likely to relapse and, therefore, orthognathic surgery will also be necessary to contribute to treatment (Figure 7).

When the patient is not going through a growth period, and when the cephalometric study indicates that mandibular length is longer than normal and accompanied by a very negative facial curvature (distance of A from Na-Pog), then we are faced with a case of surgical skeletal Class III (Figure 8). Ricketts refers to surgical skeletal Class III as a Class III surgical syndrome, characterised by 12 points, which he classifies into four groups: A) The Cranial

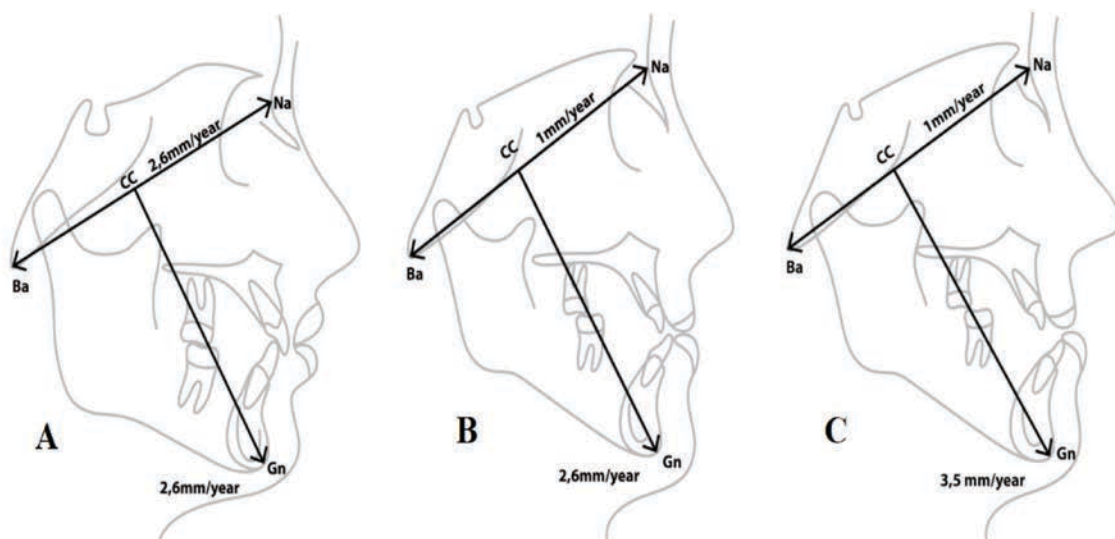


Figure 7. Growth of the cranial base (Na-Ba) and the facial axis on the chin level: A) both are normal; B) reduced growth of the cranial base and normal growth of the facial axis on the chin level; C) reduced cranial base growth and excessive growth of the facial axis on the chin level

Cases, which include: 1. Cranial deviation angle over 27°; 2. a short anterior cranial base; 3. Po-Ptv distance under 39mm. B) the Mandibular Cases: 4. Anterior position of the mandibular ramus (Xi-Ptv under 15°); 5. The neck of the condylar process is narrow and long; 6. Obtuse mandibular arc angle; 7. Long mandibular body exceeding 67mm; C) The Facial Cases: 8. Facial angle exceeding 90°; 9. Negative curvature; 10. Concave facial profile, and D) The Dental Cases: 11. Molar-canine Class III relationship; 12. Anterior incisor cross-bite¹⁰ (Figure 9).

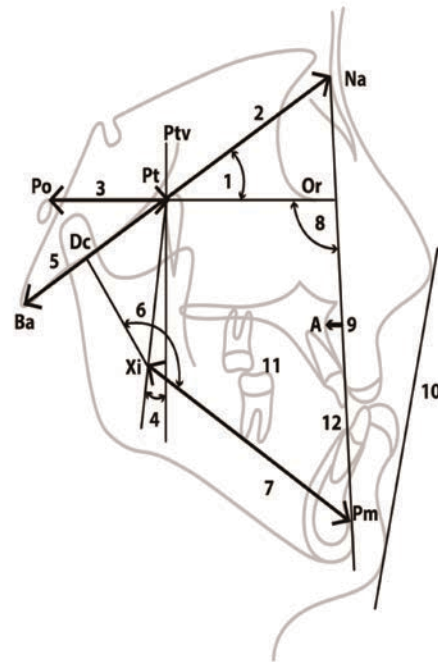


Figure 9. The twelve cephalometric points that characterize a surgical skeletal Class III case

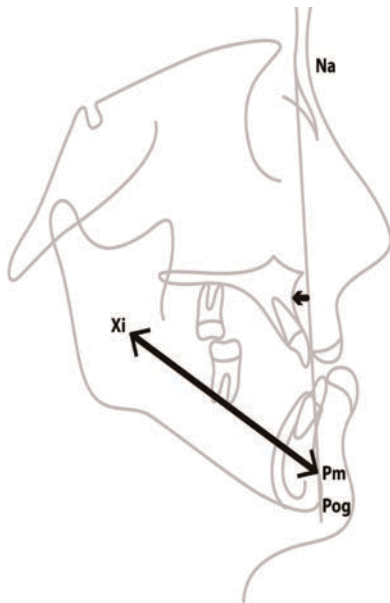


Figure 8. When the mandibular body length exceeds one standard deviation and is combined with excessive negative curvature of the face, the case encountered is a surgical skeletal Class III

Proffit's 'Envelope of Discrepancy' can be an aid to differential diagnosis of skeletal surgical and non-surgical Class III²⁷ (Figure 10). These are two graphs presenting the amount of changes that may be caused by various Class III treatment approaches on the antero-posterior and vertical levels. These graphs comprise three concentric circles. The inner circle of each graph denotes the limits

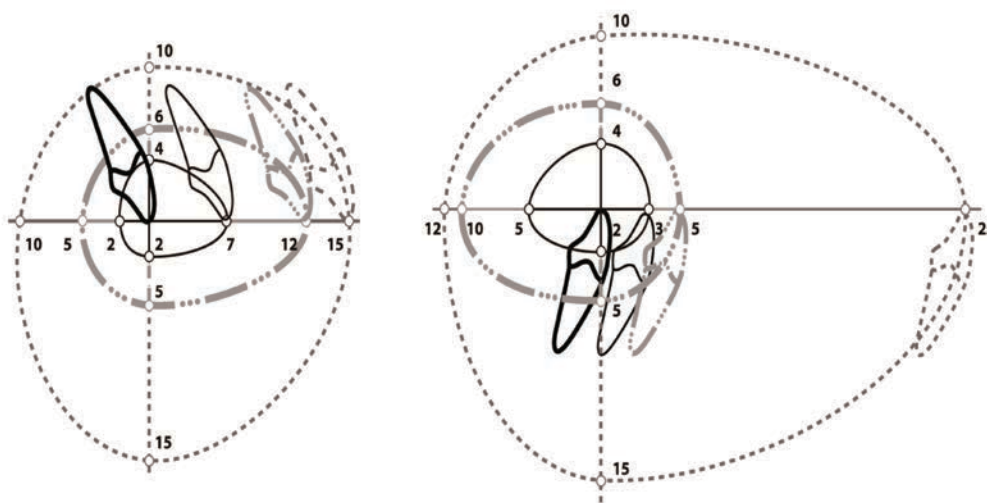


Figure 10. Proffit's 'Envelope of Discrepancy'

of discrepancy with potential for treating the problem with orthodontics alone. The middle circle denotes the limits within which combined treatment is possible (feasible) by growth modification and orthodontic tooth movement of growing patients. Finally, the outer circle presents the limits of a discrepancy, the treatment of which requires orthognathic surgical treatment.

The limits for each type of treatment are not precise, since some of them are based on research data and some on clinical observations. Therefore, absolute numerical figures defining the limits of the three circles of the 'Envelope of Discrepancy' are less significant than the concept that accompanies the creation of the 'Envelope'. According to this concept, normal dental occlusion should be accompanied by satisfactory facial aesthetics⁵¹. It also considers age as a very significant factor when taking a decision leading to the treatment method to be chosen for the correction of a skeletal Class III malocclusion case. So, in a growing patient, a Class III discrepancy may be treated only with orthodontics, while the same discrepancy in an adult case may not be treatable without surgery.

The simplest answer to the question "Who is a good candidate for orthognathic surgery?" is that surgical treatment is necessary when there is a severe skeletal or a very severe denotalveolar problem, the severity of which makes orthodontic treatment on its own inadequate. The answer to the question "What is it that makes a problem too severe to be treated with orthodontics alone?" is multi-factorial and complex. For a growing patient, the problem is so severe that it cannot be treated with orthodontics alone, when it is not possible to correct it with combined growth modification and orthodontic tooth movement (camouflage)⁴⁷. In the case of an adult patient, if the skeletal discrepancy of the jaws is too great to be compensated for using only orthodontic tooth movement alone, then surgery is necessary to achieve satisfactory normal occlusion and to improve facial aesthetics.

Conclusions

The differential diagnosis of skeletal Class III, which is a rare hereditary abnormality of the teeth and the jaws, is mainly performed on the basis of clinical examination, analysis of lateral cephalographic radiographs, as well as study of the patient's facial profile photographs. To properly treat a skeletal Class III case, it is initially important to achieve differential diagnosis between it and pseudo Class III. Then, the aetiopathogenesis of Class III has to be determined, which will indicate if it is only the maxilla or only the mandible or both jaws that cause(s) the problem. Finally, the severity of a skeletal Class III case needs to be defined, so as to determine whether it can be treated with orthodontics alone or orthognathic surgery is also required.

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