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Etiology, Development, Diagnosis and Considerations in Treatment of the Class II, Division 2 Malocclusion: What the Clinician Should Know About This Malocclusion (Part I)

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Abstract
The Class II Division 2 malocclusion has puzzled a great many orthodontists over the years. How does it develop and how does it get its characteristic appearance? What are the etiological factors that lead to the typical arrangement of the front teeth? How should we treat it? These are just a few of the many questions that still need answers. In this article we will discuss the etiology and development of this malocclusion and in Part II provide some guidelines for timing and correction of the Class II, Div. 2 malocclusion that are applicable to most cases. We shall also discuss how to predict the development of this malocclusion to enable the clinician to intercept the development at the right time. Finally, we will provide some guidelines for the retention protocol to improve the long-term stability.

Keywords
Class II; Div. 2 malocclusion; Etiology; Development; Long-term stability

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Etiology, Development, Diagnosis and Considerations in Treatment of the Class II, Division 2 Malocclusion: What the Clinician Should Know About This Malocclusion (Part I)

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ABSTRACT

The Class II Division 2 malocclusion has puzzled a great many orthodontists over the years. How does it develop and how does it get its characteristic appearance? What are the etiological factors that lead to the typical arrangement of the front teeth? How should we treat it? These are just a few of the many questions that still need answers. In this article we will discuss the etiology and development of this malocclusion and in Part II provide some guidelines for timing and correction of the Class II, Div. 2 malocclusion that are applicable to most cases. We shall also discuss how to predict the development of this malocclusion to enable the clinician to intercept the development at the right time. Finally, we will provide some guidelines for the retention protocol to improve the long-term stability.

INTRODUCTION

When Edward H. Angle, around 1900, defined and described this malocclusion, he referred to it as being characterized by having a Class II molar occlusion with retroclination of the upper front teeth (Figure 1). He also noted that the upper dental arch was characterized by less narrowing than seen in Class II, Division 1 malocclusion patients. The actual wording was as follows:

“The second division is characterized by less narrowing of the upper arch, lingual version of the upper incisors, and more or less bunching of the same. It is associated with normal nasal and lip function”.

Notice that he had observed that there sometimes was crowding to a greater or lesser degree of the teeth which he referred to as “bunching.” It is assumed, by Angle, that the reader was aware he was talking about the Class II malocclusion.

With respect to the treatment possibilities he also was offering two options. One was a non-extraction approach and the other the removal of two upper bicuspids while the lower arch was treated without extractions. He expressed it as follows:

There are two possible plans of treatment:

“The first is to improve the occlusion only, while the second has for its objective not only the establishment of normal occlusion, but the best attainable degree of improvement of the face, being and effort toward the ideal.”

“The first plan of treatment calls for extraction of two bicuspids, preferably the first.”

“The second plan of treatment uses expansion of the teeth and appliances that makes the jaw close forward.”

Angle. E. H. 1900
Before we discuss the actual treatment aspects of this malocclusion it would be appropriate to understand the etiology and development of this malocclusion from the knowledge we have today of facial growth and muscle function.

**Etiology**

It has for many years been the tradition among orthodontists to view Class II Div. 1 and 2 malocclusions as primarily being due to sagittal jaw discrepancies. However, in most of these cases there is also a strong vertical component that should not be ignored. It is true though, that a sagittal skeletal discrepancy often is present in these cases. This is in some cases in part the reason for the Class II molar occlusion. However, there is also frequently a discrepancy that is primarily dento-alveolar associated with these malocclusions that similarly can result in a Class II molar relationship. In some of these cases, there actually is no sagittal or horizontal skeletal discrepancy. The vertical jaw dimension is frequently thought to be reduced in patients with Class II, Div. 2 malocclusion; however, studies by Cleall and BeGole have shown that on average the vertical face height is normal. This may come as a surprise to many clinicians who expect facial height to be reduced in these patients.

What leads to the development of this malocclusion? The primary culprit behind the Class II, Div. 2 malocclusions development is the facial growth pattern of the individual. Numerous articles have dealt with the facial morphology of patients with a Class II, Div. 2 malocclusion, but few have described the facial growth pattern in these patients. One article that demonstrated the dynamics of the growth pattern associated with the Class II, Div. 2 development was published by Björk and Skieller. In this article one of their examples, studied with metallic implants, shows the facial growth and development of a patient over a six-year period around puberty. The analysis of this patient shows that the growth pattern was characterized by pronounced anterior or forward growth rotation of both the maxilla and mandible (Figure 2).

With poor anterior tooth contact the front teeth in this patient missed each other during eruption resulting in a continued deepening of the bite. Björk had already in earlier articles described this rotational phenomenon of the mandible and explained
that it could lead to development of a deep overbite. For most clinicians this important observation unfortunately seems to be of more academic interest than of practical clinical use. In fact, few studies have since dealt with the role of growth rotation as a major contributor to deep bite. The clinical outcome of growth rotations of the jaws in patients with poor anterior occlusion (insufficient fulcrum point) at the incisors is that not only does the bite get deeper over time, but the anterior face height also changes as a result. The growth rotation when pronounced results in a collapse not only of the bite but also in a more concave profile, a more prominent chin and dento-alveolar retrusion in the lower jaw, as seen in the adult patient in Figure 3.

It is important to remember that rotational growth changes continue throughout the growth period until all mandibular growth is completed, and that this rotation is at its peak during puberty. An example of this is seen in Figure 4.

Mandibular condylar growth direction in patients with this type of growth pattern as seen here typically is upwards and forward (Figure 4C). The superimposition, made on the metallic implants, shows the remodeling changes of the mandibular outer surface as well as the tooth movements. The anterior lower mandibular border shows appositional changes whereas the lower posterior border underwent resorptive remodeling. These changes would have been missed with conventional best fit superimposition had it not been for the stable radiographic markers used for superimposition.

Some degree of anterior growth rotation of the jaws takes place in most patients, but in Class II, Div. 2 patients, it is of greater importance than in most other cases as it plays a major role in the overbite collapse. However, in some subjects the occlusion despite the rotation of the mandible remains stable over time so it would be worthwhile to understand how the bite can remain unchanged despite the growth pattern. The two subjects seen in Figure 5, that were studied using metallic implants, both show pronounced forward mandibular growth rotation over a period of 6 years around puberty.

The overjet and overbite in both cases remained unchanged as the anterior occlusion provided a sufficiently stable fulcrum point. Undoubtedly the soft tissue function of tongue and lips play an important role in driving the lower incisors forward to the stability seen here. Clinically this is in fact what orthodontists attempt to copy when using reverse curve round archwires in the lower arch and combine this with Class II elastics. Why round wire you may ask? This detail is important to avoid bringing the lower incisor roots forward and achieve a pure tipping motion.

What is the difference in eruption pattern of the incisors between a Class II, Div.1 and a Class II, Div. 2 malocclusion? The two examples seen in Figure 6 demonstrate this difference in eruption pattern.

Also note the similarity between the mesial migration pattern of both upper and lower posterior teeth in the two subjects. Another consideration to
keep in mind is that with little or no possibility for forward movement of the lower incisors in a Class II, Div. 2 example crowding of the lower incisors often develops. An important question to answer is what causes the incisors in the maxilla to become and remain retroclined in Div. 2 cases? To better understand this dental development, we need to look at two published studies, one by Dr. Posen et al. and another by Thüer and Ingervall.\textsuperscript{7,8} Both studies examined lip function in patients with various malocclusions including Class II, Div. 2.

Posen using a so called Pommeter to measure lip tension in patients with different malocclusions concluded that in subjects with Class II, Div. 2
malocclusion the upper lip exerted increased pressure on the upper incisors thereby causing these teeth to become retroclined. Thüer and Ingervall using EMG and the so-called Pommeter (initially developed by Posen) came to a different conclusion. They reported that not only was the upper lip pressure of Div. 2 much less than in both Class I, Class II, Div.1, but that it was the lower and not the upper lip that caused the retroclination of the front teeth. In addition to measuring lip pressure and lip strength with the Pommeter they also measured the vertical relationship of the lower lip to the upper incisors and found that in Class II, 2 patients the lip was positioned significantly higher up on the incisors than in Class I and Class II, Div.1 cases as seen in Figure 7.

Figure 5. A, examples of stable anterior occlusion despite pronounced anterior or forward rotation of the mandible during growth. B, superimposition on the mandibular implants show that the mandibular incisors proclined during the growth period to maintain the anterior occlusion (from Björk et al., 1972).

Figure 6. Examples of growth patterns in untreated subjects with Class II malocclusions observed over a 5-year period. A, subject with a Class II, Div. 1 malocclusion where the eruption of the maxillary incisors is downward and forward. Notice that the lower incisors remained nearly unchanged in their inclination whereas the upper incisors become more proclined increasing the overjet. This change is possibly the result of a lower lip dysfunction often seen in patients with this malocclusion. B, subject with a Class II, Div. 2 malocclusion where the incisors in the maxilla erupt straight vertical due to lack of anterior tooth contact with the lower incisors. This results in a further deepening of the overbite (Nielsen).
In summary, the skeletal and dento-alveolar changes in patients with Class II, Div. 2 malocclusion are in part the result of the inherited facial growth pattern as discussed that in some cases causes forward rotation of the mandible during growth, in part the anterior tooth contact. Additionally, the position of the lower lip position relative to the maxillary incisors that on average is significantly higher up on the maxillary incisors than in other malocclusions. The growth rotations affect both the maxillary and the mandibular dentition and often results in the characteristic dental arrangement seen in Figure 8. Notice the severe retroclination of the maxillary incisors, the blocked-out canines and the crowding in the lower arch (see Figure 9).

As a result of the maxilla's forward rotation the maxillary first molars show pronounced mesial inclination whereas the mandibular first molars are very upright. The lower molars have assumed this upright position because they followed the mandibular forward rotation and thereby became more distally inclined where the maxilla's rotation, also in a forward direction resulted in a more mesial inclination. In other words when both jaws rotate forward the dental arches follow this rotation. Notice also the broad upper and lower dental arches typical for this malocclusion (Figure 8). This was mentioned early on by Angle in his description of the Class II, Div. 2 malocclusion when he stated that “the second division is characterized by less narrowing of the upper arch” he could have added that this also is the case for the lower arch. The lower arch crowding develops as a result of forward movement of the posterior teeth with no possibility for the incisors to procline due to the vertical inclination of the upper incisors and the severe overbite. If we combine the effect of the anterior growth rotation of the maxilla, that normally would be expected to tip the upper incisors forward, with the higher lower lip position it makes sense that the upper incisors erupt vertically and end up looking retroclined.

To summarize, in Class I and Class II, Div. 1 cases the lower lip position is significantly different from the position in Class II Div. 2 cases, and this prevents the upper incisors from proclining when the maxilla rotates anteriorly.

An important question to ask is why does the upper anterior teeth crowd in these patients and secondly why does the arrangement of the front teeth vary from patient to patient? The answer to the first questions is that it is the result of the rotation of the maxilla in combination with the restraining forces of the lower lip position.
effect of the lower lip on the front teeth while at the same time the posterior teeth migrate mesially. The answer to the second question is that the eruption sequence of the anterior teeth affects the alignment of the teeth as a result in some cases the lateral incisors become blocked out; in others it may be the canines. Another factor that can determine the alignment is the available space in the arch when the canines or the lateral incisors erupt.

**Mandibular arch changes**

The transverse dental arch dimension of the mandibular arch in patients with a Class II, Div. 2 malocclusion tends to narrow with time as the teeth follow the rotation of the jaw during growth. This in some case can result in a narrowing of the lower dental arch and even a buccal crossbite in some cases, something we will address further in Part II of this article.

Understanding the dynamics of facial growth and development and the associated tooth movements in patients with this malocclusion is instructive when it comes to diagnosing and treating patients with this malocclusion. Additionally, it is also important to understand that the treated malocclusion can be affected when this growth pattern continues after treatment making a proper retention protocol very important. More about this point later in Part II.

**Predicting mandibular growth rotation**

With the knowledge of the importance of understanding the growth patterns of maxilla and mandible in the more pronounced cases of anterior rotation it can be a great help in planning treatment and retention to know and to foresee this development. Unfortunately for most clinicians, the word “prediction” implies to be able to know precisely how much and in which direction the mandible will grow, and how the face will develop at any given age in a growing patient. However, predicting growth is a very complicated undertaking as it is multifactorial in nature. Here in addition to the natural growth tendencies of the jaws are affected by several factors including the stage of maturation of the patient, individual variations in growth intensity as well as treatment mechanics also play a role.

When Björk, after having carefully studied facial growth with metallic implants, concluded that it is possible to some degree to predict future mandibular growth rotation by looking at certain structural signs in the mandible he did not imply that this was a prediction of precise changes in amount and direction, but of the rotational potential based on certain structural signs. This technique is very different from precisely predicting future mandibular growth, which is still not possible due to the multiple factors involved. However, his technique is still valuable as it helps the clinician foresee future development potential. From his studies we know that the mandible undergoes surface modeling during growth, and it is these changes that can tell us about the rotational potential. With this knowledge the clinician can assess the lateral headfilm and decide which vertical changes can be expected during and after treatment.

In his article “prediction of mandibular growth rotation”, Björk originally listed seven structural signs that he consistently found could help predict mandibular growth rotation in untreated subjects and these included:

1. Inclination of the condylar head.
2. Curvature of the mandibular canal.
3. Shape of the lower border of the mandible.
4. Inclination of the mandibular symphysis.
5. Intercisal angle.
6. Inter premolar or inter molar angles.
7. Anterior lower face height.

Over time, we have found that some of Björk’s original predictors are hard to identify on a lateral headfilm for several reasons including the quality of the film as it can vary considerably. Often the condylar head inclination and the curvature of the mandibular canal can be hard to see so these criteria have since been replaced by other predictors that are easier to recognize. The prediction criteria now instead include the shape and thickness of the lower border of the symphysis. Currently used predictors of mandibular growth rotations are shown on the cephalometric headfilm and listed below (Figure 10).

Several authors have claimed that predicting growth rotations in treated and in untreated cases is not accurate (Lee, R. et al. and Leslie et al.). One of these studies was based on treated cases, in which the mechanics can influence the rotational changes to a great extent because of induced tooth movements. The other study used a series of randomly selected untreated subjects, but this may have included individuals with little or no growth rotation. A study by Skieller et al. including more extreme facial profiles from Björk’s collection of implant cases showed that using the above-mentioned structural signs correlated well with the individual growth rotation. It should be said though that including cases with more extreme growth patterns undoubtedly could affect the predictability of the rotational tendencies. However, the intention with the study was not to devise an accurate prediction technique, but to make it clear that if the mandible is expected to rotate anteriorly or forward during treatment and after, it must be taken into consideration during treatment as well as retention planning.

CONCLUSION

In this review article we have discussed the etiology and development of the Class II, Div. 2 malocclusion to provide a better understanding of the factors responsible for the development of this malocclusion. We have in detail shown how growth rotations in particular of the mandible can lead to a deep overbite when there is poor anterior tooth contact during the eruption of the teeth. We have further demonstrated the role of the soft tissues in particular the lips and how they play an important role in the development and arrangement of the anterior teeth.

In the subsequent Part II of this article, we shall discuss several aspects of treatment, concerns around extractions of teeth and the timing of treatment of his malocclusion. Finally, we shall review important aspects of the retention protocol to ensure the long-term stability post treatment.

Conflict of Interest Statement

The author declare no conflicts of interest.

REFERENCES


Figure 10. Structural criteria used in predicting anterior growth rotation of the mandible. 1. Shape of the lower border. The anterior part is downward convex (blue). 2. Thickness of the lower part of the mandibular symphysis (red). 3. Inclination of the symphysis. Forward inclination suggesting anterior rotation tendency (green). 4. Lower anterior face height. 5. Inclination of the upper and lower molars to each other (inter-molar angle).


