

Class II Treatment with Clear Aligners-A Review

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INTRODUCTION

Malocclusion is defined as a divergence from optimal occlusion. The type of divergence varies, but complications may be caused by any type of malalignment. Malocclusion can be skeletal or dental.¹Skeletal Class II malocclusion is a common orthodontic problem, mostly the mechanism of which is hypoplasia or retraction of the mandible². Class II malocclusions may be characterized by a protruded maxilla, retruded mandible, or both. Other variants of Class II skeletal malocclusion can be related to an increase in the length of the anterior cranial base or alterations in the vertical dimension, resulting in anteroposterior deficiencies. An increase in the anterior face height with a steep occlusal plane will also rotate the mandible backward and position the mandibular dentition into a Class II relationship.³

Management of Class II malocclusions falls into 3 main categories: growth modification, camouflage, and surgical intervention. Growth modification is ideally 1-2 years before the peak of the growth spurt.³Differing from the epiphyseal plates of long bones, the condylar cartilage responds positively to mechanical stimulation. Therefore, for such adolescent patients, the ideal treatment method is enhancing the growth and development potential of the condyle to correct the sagittal dysregulation of both jaws and reduce the possibility of orthognathic surgery in adulthood. Functional appliance has been used to correct skeletal class II malocclusion with a history of over 100 years since Robin and Andresen found it effective in stimulating mandibular growth.²

Growth modification may be performed using appliances such as headgear that deliver extraoral forces by redirecting the growth of the maxilla and allowing the mandible to develop further forward. Functional appliances may reposition the mandibular condyle in a more forward position within the glenoid fossa, allowing upward and backward condylar remodeling and differential tooth movement of the maxillary and mandibular molars. One of the objectives of using functional appliances in the treatment of growing patients with a Class II relationship is to eliminate functional problems such as lip trap and sucking habits, prevention of traumatic injury to proclined maxillary incisors, improve the convexity of facial esthetics, and stimulate the growth of the mandible to achieve better occlusal harmony and stability during the development of the face³

Clear aligner therapy (CAT) is an accepted part of modern orthodontic practice. Frequently cited advantages include less chair time, fewer office visits, easier oral hygiene, and an aesthetic alternative to fixed appliance therapy. Recent studies have indicated that Invisalign is one of the most used appliance globally. Invisalign (Align Technology, San Jose, Calif) uses three-dimensional technology to facilitate treatment planning and aligner fabrication processes. Align provides a digital interface, ClinCheck Pro, which enables the clinician to formulate a digital treatment plan. Once the clinician approves the plan, Align manufactures the sequence of aligners and they are sent to the clinician. Several investigations indicated that the initial DTP is routinely followed up by one or more refinement plans in which additional series of aligners are prescribed to achieve treatment objectives.⁴

DIAGNOSIS AND CASE SELECTION

Fig 1-Treatment options for Class II malocclusion.

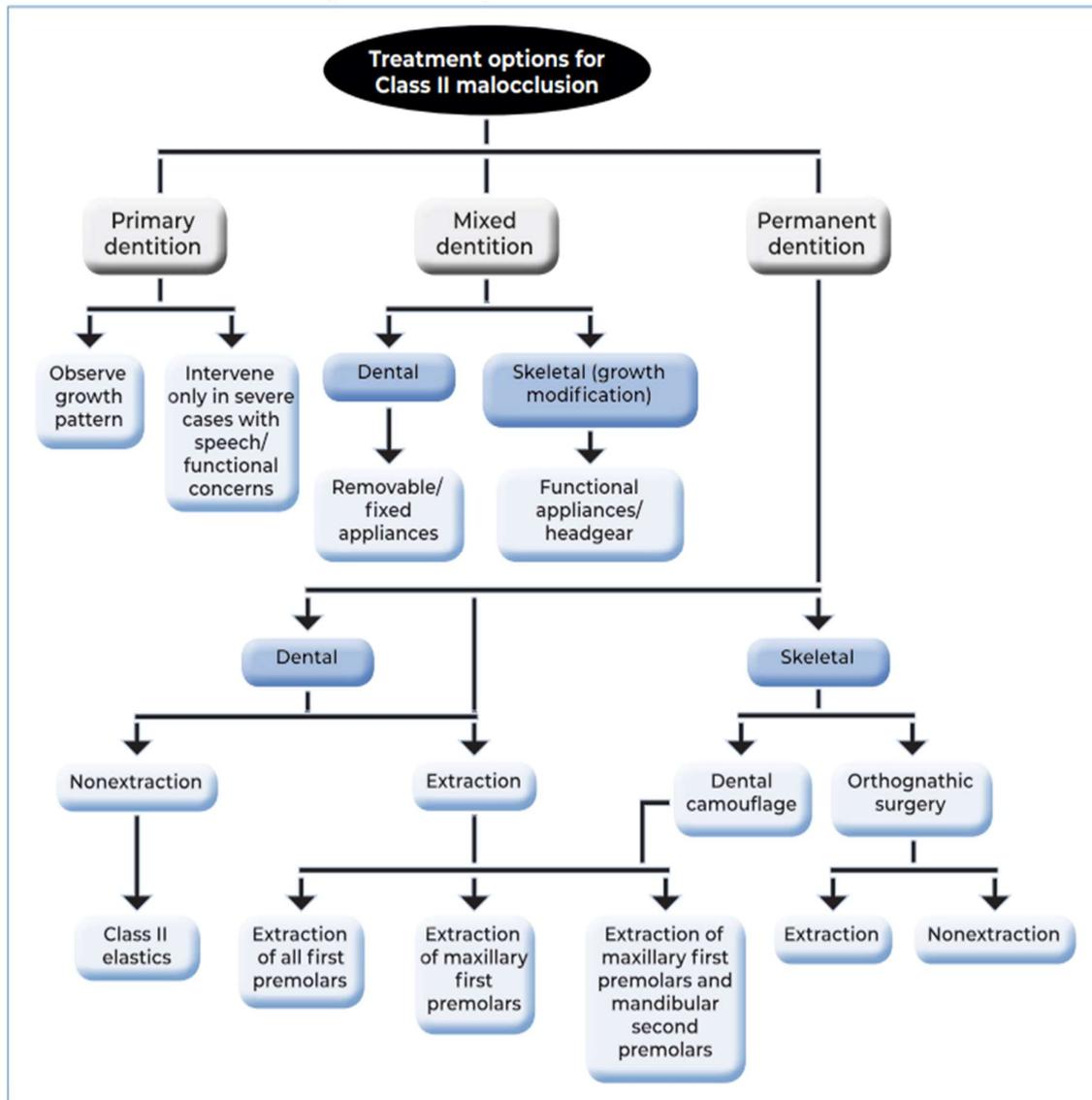


TABLE 10-1 Indications for Class II treatment

	CLASS II SIMULATION JUMP	SEQUENTIAL DISTALIZATION	MANDIBULAR ADVANCEMENT	EXTRACTIONS (DENTAL CAMOUFLAGE)	ORTHOGNATHIC SURGERY
Age	Growing teens, nongrowing adults	Any age	Growing teens and younger	Preferably nongrowing patients	Nongrowing patients
Dental classification	Up to a full cusp (2 to <4 mm) for teens, half cusp or less for adults	Half cusp or more (2 to <4 mm) for teens, half cusp (2 mm) or less for adults	Up to a full cusp (2 to <4 mm) for teens or younger	Full cusp Class II or where protrusion and crowding indicate extractions	Full cusp Class II where extractions for dental camouflage are not indicated
Skeletal pattern	Skeletal Class I or Class II tendency, but dental Class II	ANB +4 to +5 degrees, skeletal Class II tendency	ANB +4 degrees or more	ANB +4 to +6 degrees	ANB +8 to +10 degrees
Soft tissue facial profile	Orthognathic Mildly convex	Orthognathic Mildly convex	Convex profile with mandibular retrognathia requiring facial change	Mildly convex profile where lip posture can tolerate extractions	Severely convex/ retrognathic profile requiring facial change

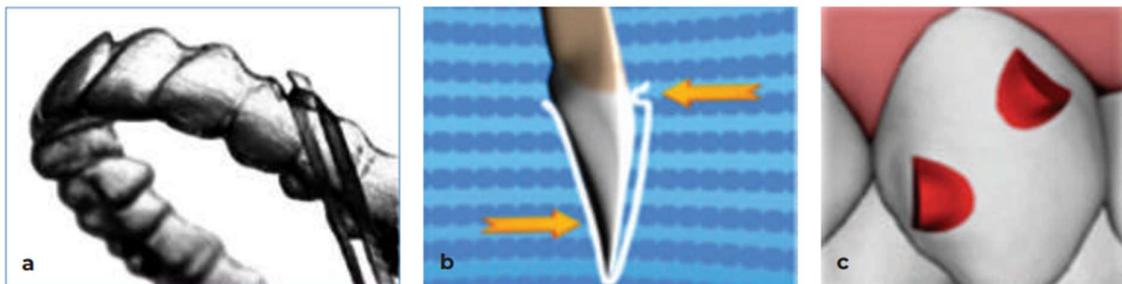
Both skeletal and dental malocclusions fall under class II. A Class II skeletal disparity can appear as retrognathic mandible or prognathic maxilla, or both. The Wits analysis is positive and the ANB angle is higher in these patients. Dental adjustments are typically visible for a Class II skeletal arrangement. The mandibular incisors will be proclined, whereas the maxillary incisors will be upright or retroclined. There might also be a vertical skeletal component. Individuals with a low mandibular plane angle in their brachyfacial skeletal pattern typically have a positive growth pattern that helps with Class II correction. Fig. 1 presents a general treatment strategy for Class II malocclusion. The diagnosis plays a crucial role in deciding which treatment techniques will be applied to address the occlusion.

An important diagnostic query that will choose the course of treatment is if there is a dental or skeletal malocclusion.

The remainder of this chapter discusses nonextraction options for Class II treatment (Table 1)

Innovations for Anteroposterior Correction

The innovations for Class II anteroposterior (AP) correction are precision cuts, power ridges, and optimized root control attachments



1. Precision Cuts

Precision cuts may be requested as precision cut hooks or button cutouts. These allow intraoral elastics to be worn for correction of Class II malocclusion with differential movement of both dental arches.

A) Precision-cut hooks in the maxillary arch When precision-cut hooks are placed in the maxillary arch on either the canines or first premolars, the intraoral elastic exerts a distal force on the entire arch because the elastic is

hooked directly to the aligner. This works well in Class II, division 1 cases, where the maxillary incisors are proclined, as the distal force will act favourably to retract these teeth and reduce the overjet. This same principle is also helpful in reinforcing anchorage in cases where sequential distalization has been programmed for Class II correction, using the mandibular arch to reinforce anchorage for maxillary molar distalization.

b) Precision-cut hooks in the mandibular arch

Sometimes a Class II malocclusion presents with retroclined mandibular incisors. This is seen in patients with lip entrapment or a thumbsucking habit. In this case, it would be desirable to have a mesial force on the entire mandibular arch with mandibular incisor proclination. Precision-cut hooks may then be requested on the mandibular first molars for Class II elastic wear.

c) Button cutouts in the maxillary arch

Button cutouts may be requested in the maxillary arch for Class II correction in the following scenarios: • Class II, division 2 malocclusion where the maxillary incisors are retroclined • Class II malocclusion where the maxillary canines are erupted buccally and apically, requiring extrusion In Class II, division 2 malocclusions with retroclined maxillary incisors, these incisors will need to be proclined for correction of incisor inclination, deep bite, and incisor alignment. In this case, a distal force on the entire aligner may be undesirable because the maxillary incisors require the freedom to move labially as they procline. It may be undesirable to hook an elastic directly to the aligner through a precision-cut hook, so button cutouts may be requested on the maxillary canines to isolate the elastic force from the aligner. Button cutouts also work well for buccally erupted canines that may require extrusion for alignment. Alternatively, in Class II, division 2 cases, the precision-cut hook may be placed further distally, for example on the first premolars, to distance the elastic force from the maxillary incisor tooth movement.

d) Button cutouts in the mandibular arch

In Class II malocclusions, the mandibular incisors are often proclined in an attempt at dental compensation. However, it is critical to manage the mandibular incisor inclination carefully for stability and periodontal reasons, and clear aligners offer better control of this inclination. The treatment-planning software allows clinicians to (1) request that the pretreatment inclination of the mandibular incisor be maintained, (2) incorporate interproximal reduction into the treatment plan to retrocline the mandibular incisors, and (3) use the superimposition tool to compare the pre- and posttreatment positions of these teeth. In cases where the mandibular incisors are already proclined, it would be undesirable to further increase the proclination, which is often seen as a detrimental effect of Class II elastic wear. Therefore, button cutouts are often requested on the mandibular molars. This isolates the elastic force from the aligner and provides more control over mandibular incisor inclination.

2. Power Ridges

In Class II, division 2 malocclusions, the maxillary incisors are retroclined. Before the advent of power ridges, it was very challenging to correct this incisor inclination and its associated deep bite. Power ridges may now be placed on the maxillary incisors for lingual root torque to correct the maxillary incisor inclination.

3. Optimized Root Control Attachments

Optimized root control attachments allow for bodily translation of teeth when distalizing maxillary molars, premolars, and canines to correct a Class II malocclusion.

4. Posterior Interproximal Reduction

Posterior interproximal reduction (IPR) in conjunction with anterior IPR may be prescribed for the following reasons: • For resolution of crowding • To correct any tooth size discrepancy, particularly if the maxillary second premolars are small in morphology • To retract the maxillary canines into a Class I relationship • To decrease the amount of overall maxillary molar distalization required Posterior IPR may be prescribed for AP correction, where the molars may be in a Class I relationship but the canines are in a mild Class II relationship. It may also be prescribed where there is posterior crowding or a buccally displaced canine. In this case, the space created through posterior IPR allows the canine to be aligned and retracted into a Class I relationship. The prescription form would indicate to “Improve canine relationship only” (Fig 10-4)

Sequential Distalization

Sequential distalization of the maxillary molars is a predictable way of correcting a half-cusp Class II malocclusion. Sequential distalization may also be prescribed in combination with posterior IPR and/or Class II elastic simulation. For example, in a full-cusp Class II malocclusion, sequential distalization may be programmed in for half a cusp and an elastic simulation jump added for another half cusp to fully correct to Class I. When sequential distalization is pre scribed in combination with posterior IPR, the amount of distalization required to correct to a Class I molar and canine relationship is reduced. Sequential distalization may be supported by Class II elastic wear for interarch anchorage. Therefore, precision cuts for Class II elastics may also be requested. Class II elastics are worn to reinforce anchorage and to aid tooth movements already built into the aligner. This does not necessarily mean that there will be a simulation jump to correct to Class I, unless a simulation jump has been

specifically requested. Depending on the age of the patient and the amount of distalization required, Class II elastics may be worn full-time or part-time. En masse distalization may also be attempted by placing temporary anchorage devices (TADs) if more anchorage is required. Buccally placed TADs may be engaged with removable intraoral elastics attached to precision-cut hooks on the maxillary canines of the aligner. Alternatively, the TAD may be engaged with a power thread, elastomeric chain, or nickel-titanium closing coil to a power arm on the maxillary canines or first premolars. Palatally placed TADs may require a bonded transpalatal arch for engagement. Sequential distalization is also commonly referred to as “V-pattern” staging (Fig 10-8). An important fact to remember is that aligners push on teeth. The dental arch from first molar to first molar acts as an anchorage segment to push the second molars distally. When the second molar has moved halfway, the first molar starts to distalize. When the first molar has moved halfway, the second premolar starts to distalize. By this time the second molar would have stopped moving. When the first molar stops moving, then the first premolar starts to move, then the canine, and finally the anterior segment. This is a very conservative anchorage setup, and clear aligners allow us to distalize molars without concurrent labial movement of the maxillary incisors. There is a mild difference in the staging pattern for Class II, division 2 cases. The posterior teeth move in a similar V pattern, but the maxillary incisors also start moving from stage 1. Class II, division 2 cases are staged very similar to how they would be treated with fixed appliances. In fixed appliance treatment, the incisors are aligned and proclined to their proper inclination first, essentially converting a Class II, division 2 malocclusion to a Class II, division 1 malocclusion. The dental arches are then leveled and the overjet decreased through incisor retraction. In clear aligner treatment, the maxillary incisor tooth movement is staged in a sequence of “procline, intrude, retract.” The maxillary incisors are first proclined to correct the incisor to its proper inclination.

Growth Modification with the Mandibular Advancement Feature

Historically, clear aligners did not have the potential to address Class II skeletal discrepancies. Growing patients with mandibular retrognathia would first be treated with headgear or a functional appliance such as the Bionator, Twin Block, or Herbst to correct the skeletal discrepancy. Once the case was corrected to Class I, then clear aligners would be used in the second phase of treatment for alignment, leveling, and finishing. In 2017, Align Technology introduced Invisalign with the mandibular advancement feature. This appliance resembles a clear aligner with the addition of a feature called “precision wings” placed on the buccal surface of both aligners. These precision wings interlock in occlusion to posture the mandible forward for Class II correction. This new appliance for Class II correction holds great promise in the correction of Class II skeletal discrepancies with mandibular retrognathia. Preliminary data from a multicenter study begun in 2015 demonstrate a decrease in overjet and overbite, a decrease in ANB angle, an increase in SNB, and a decrease in facial convexity for Class II correction (unpublished data, 2017).

DISCUSSION

As the Mandibular Advancement appliance has only been used clinically since 2017, the literature on its effectiveness is limited globally and mostly consists of case studies⁴

Previous studies investigating the effects of the Mandibular Advancement appliance on patients with Class II Division 1 malocclusion have reported skeletal and dental changes. For example, Blackham observed that the Mandibular Advancement appliance is effective in improving skeletal and soft tissue convexity, the Wits appraisal, and the ANB angle⁵. Caruso et al.⁴ and by Ravera et al.⁶ effectively improved face convexity and the Wits index. Blackham⁵ found that the overjet was decreased through retraction of the upper incisors and protrusion of the lower incisors, and the overbite was also reduced. Ravera et al.⁶ showed that if the patients were at cervical vertebrae maturation growth stage 2 (CVM2), the Mandibular Advancement appliance would produce more dentoalveolar effects; whereas if the patients were at CVM3, the skeletal component of the Class II correction was greater. The most recent study by Wu et al.⁷ compared four devices: the Vanbeek Activator (n=14); Herbst (n=11); TwinBlock (n=12); and MA (n=14) in patients with Class II malocclusion with ANB 4 or higher and CVM stage 2. Growth stimulation of the mandible was observed in Twin-Block and MA (Co-Go and Co-Pog) and Herbst (Co-Pog), while maxillary inhibition was only observed in Vanbeek Activator. This result was consistent with previous studies that reported that headgear had some effects on maxillary restraint.^{8,9} However, clinically significant restraint of maxillary growth was not clear in other functional appliances^{10,11}

As the IMAF appliance is new to clinical practice, there is limited literature on its efficiency, consisting mostly of case studies. Blackham conducted a retrospective cephalometric study to measure the skeletal, dental, and soft tissue effects of the IMAF. The results of this study indicate that the IMAF is effective in improving skeletal and soft tissue convexity, the Wits appraisal, and the ANB angle.⁵ These results are in agreement with a retrospective controlled study by Caruso et al. and a prospective controlled study by Ravera et al. who also found the IMAF to be effective in improving face convexity⁴ and the Wits index.⁶ Blackham found that the overjet was decreased through retraction of the upper incisors and protrusion of the lower incisors and the overbite was also reduced.⁵ Ravera et al. showed that if the patients were at CVM2 growth stage, the IMAF appliance would produce more dentoalveolar effects whereas if the patients were at CVM3 growth stage, the skeletal component of the Class II

correction was greater. ⁶As with all functional appliances therefore, correction of the Class II malocclusion with the IMAF appliance is achieved through both skeletal and dental changes ^{4,5,6}. The IMAF appliance appears to be successful in the treatment of Class II malocclusion with mandibular retrognathism in a growing patient. As with all functional appliances, the correction of the malocclusion is a result of both skeletal and dental effects and the IMAF presents the advantage of producing less proclination of the lower incisors compared to other functional appliances.

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