Planning restorative treatment for patients with severe Class II malocclusions

Alberto Ambard, DDS, MS,a and Leonard Mueninghoff, DDSb
School of Dentistry, University of Alabama at Birmingham, Ala.

This article describes a clinical protocol for the occlusal rehabilitation of patients with severe angle skeletal Class II malocclusions. Within this protocol, an occlusal device is used for 2 purposes: first, to locate the most suitable maxillary-mandibular relationship for function and range of motion at an established vertical dimension of occlusion; and second, to accurately transfer this relationship to an articulator for fabrication of provisional and definitive restorations. The theory behind this protocol and its associated clinical procedures is presented along with a discussion of the protocol’s advantages and disadvantages. (J Prosthet Dent 2002;88:200-7.)

The prosthodontic treatment of severe Angle skeletal Class II malocclusions is challenging. Ideally, these malocclusions should be identified at an early age and corrected with orthodontic treatment; otherwise, the individual develops a habitual position characterized by significant protrusion of the mandible during function and at rest.1-8 This is in contrast to a posterior position of the mandible when the patient is in centric relation (CR) or maximum intercuspation (MI) (Fig. 1). This article describes a clinical protocol in which fixed prosthodontic procedures are used to restore patients with severe Class II skeletal malocclusions.

CLASS II MALOCCLUSIONS
Temporomandibular disorders and Class II malocclusion

According to some authors, patient adaptation to occlusal imperfection is of clinical significance.9 Whether there is a correlation between temporomandibular disorders (TMD) and Class II malocclusions is controversial.10-13 According to some authors, approximately 15% of malocclusions are Class II.2,14 Dawson15 noted that most research on the relationship between TMD and malocclusion refers to Angle’s classification of malocclusions but does not correlate occlusal contact with the temporomandibular joint. TMD symptoms have been observed in patients with Class II malocclusions.10,11 Stamm et al13 reported that patients with Class II, Division 2, malocclusions showed steeper and longer lateral condylar inclination (LCI) and displayed a wider range of motion than patients with Class I occlusions. All participants in that study were free of TMD. Other authors have suggested that patients with Class II malocclusions may develop TMD if there is interference in the path from CR to the habitual position.16-18

No controlled study has shown a direct relationship between patients with Class II malocclusions and TMD. Restorative treatment of these patients should not be considered as preventative of TMD.

Fig. 1. Difference in mandible position of patient with Class II, Division 1, malocclusion. A, Patient in centric relation. B, Patient in habitual position. Change in facial profile is dramatic.
Treatment options for patients with Class II malocclusions

Several treatment options have been proposed for patients with Class II malocclusions.\textsuperscript{19-22} Orthodontic treatment and orthognathic surgery are the treatments of choice because they correct these malocclusions.\textsuperscript{23-26} However, orthognathic surgery involves hospitalization, a difficult postoperative phase, and elevated costs. The disadvantages of orthodontic treatment include the required time, costs, and esthetic compromise during treatment. Patient age and occupation are critical factors in the treatment decision. Prosthodontic treatment is the preferred option when the patient’s age or unwillingness to accept alternative therapy make other options less attractive.

It is important to recognize the point at which restorative modalities alone would not produce an acceptable outcome. Prosthodontic treatment will never correct the skeletal relationship. No irreversible prosthetic treatment should be performed unless the results can be clearly visualized and the functional and esthetic condition of the patient will be improved as a result of treatment.

Centric relation

Centric relation is not considered by some to be an optimal end point of masticatory function.\textsuperscript{27} Centric relation is important because it is a repeatable point of reference. Research has shown that CR varies within the same patient at different times of the day, as well as on different days.\textsuperscript{28-31} Grasso et al\textsuperscript{28} found that the greatest variation in CR records was 1.9 mm mediolaterally. Shafagh et al\textsuperscript{30} reported the dispersion pattern of CR and concluded that the deviation was not statistically significant.

When patients with Class II malocclusions are restored, difficulties may arise as a result of the difference between CR and the habitual position. If severe horizontal overlap is present, it may be difficult to obtain contact between the anterior teeth at CR. With most of these patients, contact may not be necessary. Stable contacts in the posterior teeth can hold the vertical dimension of occlusion (VDO). Extrusion is rare given that most patients with Class II malocclusion function at MI\textsuperscript{1-7} (Fig. 2). The appearance of a Class I occlusal relationship and MI may be present at the habitual position (Fig. 1, B). Anterior guidance can be developed from this position as though the patient had a Class I occlusion. The cingula of the maxillary anterior teeth should be flat so that freedom is possible from CR to MI. The cingula may be overextended slightly to obtain contact with the mandibular anterior teeth in the CR position (Fig. 3, A).

When this freedom is created, no lateral deviation of the mandible should occur in the path from CR to MI, because this may be a source of TMD.\textsuperscript{10} The length of the slide does not seem to be a significant factor in the development of TMD if the slide is symmetric. Conversely, patients with asymmetric slides of 1 mm or more appear to have a higher frequency of joint tenderness.\textsuperscript{10}

Physiological rest position and functional articulation

When in the physiological rest position, patients with Class II malocclusions place the mandible in a more protrusive position than patients with Class I occlusion\textsuperscript{1-7} (Fig. 1). Ricketts\textsuperscript{3} pointed out that the protrusive position improves esthetics, lip seal, muscle function, speech, and respiration. He and others concluded that the habitual position is an adaptive and conservative process to accommodate to excessive horizontal overlap, to open the airway, and to adjust to an abnormal skeletal pattern.\textsuperscript{3,11,39}

Patients with Class II malocclusions not only rest but also function in the habitual position, demonstrating an extensive range of movement.\textsuperscript{1,8} Interferences to this range of motion have been noted to cause discomfort.\textsuperscript{16-18} The long intercuspal contact area or long centric (LC) in patients with Class II malocclusions may be longer than the suggested 0.5 to 1 mm. Ash and Ramford\textsuperscript{40} suggested that if LC is extended beyond the range of function, no adverse effect will be observed. They identify LC as a range (rather than a defined, measurable point) that may be subject to a patient’s musculature, skeletal profile, and body type.

When patients with Class II malocclusions are restored, difficulties may arise as a result of the difference between CR and the habitual position. If severe horizontal overlap is present, it may be difficult to obtain contact between the anterior teeth at CR. With most of these patients, contact may not be necessary. Stable contacts in the posterior teeth can hold the vertical dimension of occlusion (VDO). Extrusion is rare given that most patients with Class II malocclusion function at MI\textsuperscript{1-7} (Fig. 2). The appearance of a Class I occlusal relationship and MI may be present at the habitual position (Fig. 1, B). Anterior guidance can be developed from this position as though the patient had a Class I occlusion. The cingula of the maxillary anterior teeth should be flat so that freedom is possible from CR to MI. The cingula may be overextended slightly to obtain contact with the mandibular anterior teeth in the CR position (Fig. 3, A).

When this freedom is created, no lateral deviation of the mandible should occur in the path from CR to MI, because this may be a source of TMD.\textsuperscript{10} The length of the slide does not seem to be a significant factor in the development of TMD if the slide is symmetric. Conversely, patients with asymmetric slides of 1 mm or more appear to have a higher frequency of joint tenderness.\textsuperscript{10}

Bennett movement

According to some authors, Bennett movement (BM) cannot exist because lateral movements cannot be produced from CR without a vertical drop of the condyles, given that CR is the most anterior-superior position of the condyles in the fossa and range of motion is restricted in that position.\textsuperscript{9} However, studies have shown that side shift exists and can occur in any direction.\textsuperscript{41-46} Controversy arises when the retruded starting point in some of these studies is considered. According to Schuyler,\textsuperscript{47} if BM does exist, it must be considered
because of its influence on the contours of posterior teeth.

If CR has a range, then BM does exist and can be influenced by muscle tonus; thus, BM is variable.28,48,49 For this reason, it has been proposed that an immediate side shift of 0.5 to 1 mm be allowed. Then not only the anterior but also the posterior teeth would permit freedom for muscular variation. This is referred to by some as a long and wide intercuspal contact area.27,50 When this freedom is provided, injury is not introduced to the patient if side shift does not exist, but injury is prevented if it does.16–18 The functional cusps occlude against a receiving flat area in the opposing teeth. In this situation, only minor modifications in the anatomy of the teeth are observed (Fig. 3, B).

Anterior guidance

At least one study compared group function to canine guidance and found no difference.51 The mutually protected occlusion proposed by D’Amico,52 although difficult to achieve, may be the method of choice when patients with Class II malocclusions are restored. It has been shown that disarticulation of the posterior teeth can dramatically reduce the activity of masseter muscles. It is not contact of the canines that decreases the activity of the elevator muscles, but the elimination of posterior contacts.53

As previously discussed, long and wide contact areas should be developed in the anatomy of restored teeth.16–18 Such areas permit slight eccentric movement before the influence of the lingual inclined planes of the maxillary anterior teeth produces posterior disarticulation.54

Protrusive movement should be bilateral with no lateral deviation.10 Because disarticulation of posterior teeth is desired during excursive movements, the semi-adjustable articulator should be set at least 5 degrees lower than the protrusive condylar inclination to elimi-
nate any risk of protrusive or nonworking-side occlusal interference. Although the average LCI ranges from 25 to 35 degrees, 18 degrees may be recorded for some patients.\textsuperscript{55} LCI therefore should be set with the use of a protrusive record. Bennett movement or side shift is set with right and left lateral records; the Bennett angle is preset at 15 degrees on the articulator.

Retrusive guidance

Retrusive guidance (RG), also referred to as retrusive-bracing contacts, is rarely described in the literature. According to Farrar and McCarty,\textsuperscript{56} RG consists of the contact relationship between maxillary and mandibular teeth that serves to keep the condyles from distallizing. These authors suggested distallization of the condyles as the excessive retrusion of the mandible that results in condylar function at the posterior border position of the fossae, producing trauma in this area.

Retrusive guidance is important given that muscles do not limit posterior horizontal movement of the mandible.\textsuperscript{32} This idea is in agreement with Miyoshi,\textsuperscript{57} who showed that the mandible was posterior to CR after the elimination of RG. Yang et al\textsuperscript{58} demonstrated that posterior movement of the mandible during lateral mandibular translation was strongly related to internal derangement of the TMJ.

In the opinion of some authors, RG should be developed bilaterally near CR and in lateral mandibular movements.\textsuperscript{56} Near CR, any contact that keeps the mandible from further posterior movement is a retrusive bracing contact. The guidance is developed when the anatomy of occlusal surfaces is created. It has been suggested that in lateral mandibular movement, guidance is provided through use of the mesial incline of the maxillary canine against the distal incline of the mandibular canine.\textsuperscript{56} Thus the disarticulation of all posterior teeth in lateral mandibular movement is provided, and the mandible is stopped from retrusion. In patients with Class II malocclusion, guidance is difficult to achieve, as the mandibular canines are either edge-to-edge or distal to the maxillary canines.\textsuperscript{59} In this situation, the mesial incline of the maxillary first premolar is used with the distal incline of the mandibular canine to provide guidance. The cusp of the maxillary canine may be in contact with a mandibular incisor and must be flat to provide smooth guidance.

Increased vertical dimension of occlusion

Vertical dimension of occlusion is the distance between 2 arbitrarily selected points in the maxilla and mandible when the occluding members are in contact.\textsuperscript{60} Several studies have reported that a considerable increase in VDO can be tolerated if the occlusion is established correctly.\textsuperscript{60-63} New interocclusal rest space is developed as an adaptation to a new VDO after insertion of an occlusal device and firm articulation of the patient.\textsuperscript{60,61} Periodontal receptors may determine which muscle length is an acceptable interocclusal distance at the established VDO.\textsuperscript{63-67}

It has been observed that orthodontic patients whose VDO was increased up to 8 mm reverted to their pretreatment VDO within 1 year.\textsuperscript{68} This change to the original position did not affect the corrected arch alignments or the intercuspal relationship. These results indicate that most change occurs within the alveolar bone.

Most patients with Class II malocclusions need an increased VDO to obtain the necessary maxillary/mandibular space for restorations that provide harmonious occlusion.\textsuperscript{22} Increased VDO also increases the horizontal overlap. Consequently, the desired VDO for muscle and joint comfort in Class II, Division 2, malocclusion patients leads to a horizontal overlap and function similar to that in patients with Class II, Division 1, malocclusion. Thus the restorative concept is similar for both divisions within Class II.

The closest speaking space

The closest speaking space (CSS) is the most forward and closed position of the mandible during speech.\textsuperscript{69} Regardless of whether it is edentulous, the mandible is consistently carried forward and upward to the same /S/ position level. At this position, the condyles are usually anterior to the terminal hinge position.\textsuperscript{69}

The CSS can be observed clinically by asking the patient to articulate in the maximal intercuspal position. A line is traced on the mandibular incisors or gingival tissue at the level of the maxillary incisal edge. The patient is instructed to pronounce words that contain /S/ sounds. As suggested by Morrison,\textsuperscript{70} words such as Mississippi and sixty-
six are adequate for this test. When the patient pronounces these words, the distance between the lowest level reached by the incisal edge of the maxillary incisors to the line traced on the mandible is the CSS.

This technique is suitable for Class II patients because it helps the clinician determine the amount of interocclusal space available (vertical component) if an increase in VDO is needed. It also helps the clinician observe the anterior border of the protrusive speaking motion of the patient. This horizontal and vertical relationship between the incisal edges of the anterior maxillary and mandibular teeth is important because as the patient protrudes the mandible, care must be taken to prevent interference and ensure patient comfort (Fig. 4).

It must be remembered that the CSS is a range and not an exact point because it is under muscular control. Differences among CSS registrations within the same patient are, however, minimal. The physiological rest position should not be used to determine the amount of available space because it is not a position of function and because this position is variable throughout the day.

**TREATMENT PROTOCOL FOR THE PATIENT WITH CLASS II MALOCCLUSION**

What follows is a proposed clinical protocol for treatment of the patient with Class II malocclusion

Record diagnostic impressions, CR, and face-bow orientation along with protrusive and lateral interocclusal records. Alter (deprogram) the proprioceptive mechanism for at least 20 minutes with the use of cotton rolls before obtaining the CR record. Mount 3 sets of casts in a semi-adjustable articulator (Model 2240-2003; Whip Mix Corp, Louisville, KY), and adjust the condylar elements. At the same appointment, observe the CSS to determine the vertical and horizontal space available in function.

Make a preliminary diagnostic wax-up on the basis of the increase in VDO required to mechanically place necessary restorations and to provide the patient with a proper facial profile. With the same VDO, fabricate an occlusal device, preferably for the maxillary as well as the mandibular arch to avoid interference in the wide range of motion typical of a patient with Class II malocclusion. If teeth are missing, denture teeth may be added to the occlusal device, which should be made without guidance to allow muscular freedom. The patient must use this device 24 hours a day; otherwise, his/her muscles will slowly adjust to the new VDO and never completely reach proprioceptive harmony (deprogrammed position).

The appliance establishes a comfortable VDO and deprogrammed position of the mandible. It also serves to record the characteristic dual occlusion typical of patients with Class II malocclusions. Use articulating paper of various colors to identify dual occlusion on the device. It is critical to provide freedom on the device from one position to the other and as many stable and equal contacts in all positions as possible (Fig. 5). When the patient pronounces /S/ sounds, there must be at least 1 mm between the mandibular teeth and device.

At the beginning of treatment, adjust the device every 7 days (or more often for a patient with TMD symptoms). Note changes on the device with thin articulating paper. One area of the device typically will exhibit heavier contact marks. Such marks demonstrate that the muscles are rotating the mandible in that direction. In addition to rotation, the movement may be both lateral and anterior-posterior. When no further changes are discernible, schedule appointments in 2-week intervals until no further changes are detectable. Typically after 8 weeks, no additional changes in occlusion will be evident and the patient will confirm his/her comfort. In a patient with temporomandibular symptoms, it may take one year or more to achieve deprogramming. Such patients usually function better and more comfortably with the occlusal device than without it, which is an indication the definitive reconstruction will be successful.

Accurately record the relationship between the device and mandibular teeth to obtain CR at the new VDO. Make the CR registration with a relaxed, free-hinging mandible without manipulation. The patient will go repeatedly and accurately to this same position. If the patient has dual occlusion, the clinician should have been adjusting the occlusal device at and between the 2 mandibular positions at each visit. The more protrusive positions will reveal a lateral range, whereas the most posterior position will be accurately repeatable by the patient within accepted standards.

Record the relationship by sectioning the device into 3 pieces, separating the anterior from the 2 posterior

---

**Fig. 5. Adjustment of occlusal device for patient with dual occlusion. Blue marks represent centric relation; red marks represent occlusion at habitual position. Freedom should be provided from one position to other. Jaw registrations should be recorded in centric relation.**
segments. Place the posterior portions in the mouth, and use hard wax (Bite Registration Wax; Almore International Inc, Portland, Ore.) or another suitable material to record the space between the 2 arches in the anterior region. Remove the 2 posterior segments, and use the record made in the anterior region as a vertical stop to record the relation in the posterior (Fig. 6).

Obtain an irreversible hydrocolloid impression of the maxillary arch without the device. Articulate the resulting cast using these new records with the mandibular diagnostic cast that was mounted previously. This allows a realistic relationship between the dentition at the new VDO (Fig. 7).

Reposition the 3 sections of the occlusal device in the mouth, and use orthodontic resin to reattach the pieces. Ask the patient to articulate while the acrylic is setting. Polish the device. If there are not sufficient teeth to support the device, it cannot be sectioned because it would be impossible to reassemble accurately. An alternative solution is to obtain an irreversible hydrocolloid impression with the device in place, leave the device in the impression with a thin layer of separating agent, and pour the impression. Mount the cast, with the device in place, against the mandibular cast with records made previously in the mouth. Separate the device from the cast, and return it to the patient.

With the new relationship, make a new and definitive wax-up. Given that space is present between the 2 arches, decide whether restorations are indicated for both arches or whether a harmonious occlusion can be obtained through restoration of only one arch. The restorative needs of the patients, the desired occlusal plane, and the esthetic position of the maxillary incisal edge are key factors in this decision. Do not use the initial diagnostic wax-up, as adjustments to the device resulted in changes in the relationship.

Duplicate the wax-up, and obtain matrices. Use the matrices as a reference to prepare the teeth and to fabricate the provisional restorations, which must have the same characteristics as the wax-up. For the fabrication of provisional restorations, section the occlusal device into 3 pieces. Fabricate restorations in segments with use of the occlusal device as vertical stops to maintain the VDO. Prepare the anterior teeth first, then place the posterior sections of the device in the mouth. Fabricate provisional restorations for the prepared anterior segment, and repeat the procedure for the posterior segments.

Monitor patient function with the provisional restorations for a minimum of 4 to 6 weeks before obtaining final impressions. Mount casts representing the provisional restorations and tooth preparations with appropriate interarch records. These casts serve for fabrication of an anterior guide table and provide information related to esthetics, vertical plane, incisal position, smile line, and so on. Obtain new protrusive and lateral records to reaffirm the articulator settings. If further esthetic and/or occlusal adjustments are performed between this appointment and the coping try-in appointment, obtain new casts of the provisional restorations, and fabricate a new anterior guide table. This allows a total of 10 to 12 weeks to provide for adjustments and to determine comfort with the provisional restorations. Transfer the resulting physiological relationship to the articulator for fabrication of the definitive restorations.
Advantages and disadvantages of the proposed protocol

The advantages of the proposed protocol are as follow. First, no irreversible procedures are initiated until the patient is comfortable with the resulting relationship and treatment results are visualized clearly. Second, the relationship obtained with the occlusal device after adjustments is always maintained, which diminishes clinical occlusal adjustment time and makes the clinical outcome more predictable. Third, comfort during function is achieved early in the treatment with use of the occlusal device. This is critical because the patient can see results and therefore may become more compliant. Fourth, esthetics and function are improved significantly.

At least 4 disadvantages are associated with the protocol. First, patient compliance is one key to success. If the patient does not use the occlusal device as requested, treatment time may increase or treatment may never progress. Second, to achieve predictability, multiple, frequent, and consecutive visits are needed. Some patients may not be able to comply with the requirements for successful treatment. Third, depending on the severity of the horizontal overlap, the occlusal anatomy of the posterior teeth may be altered to a less prominent or defined architecture. Finally, as with any full-mouth rehabilitation, costs are elevated, treatment is long, and an occlusal guard must always be in use when the patient sleeps.

Alternative treatment approaches

The prosthodontic treatment of patients with Class II malocclusions can be approached with various methods depending upon the philosophy of occlusion applied, the clinical situation, and the preference and experience of the clinician. Ultimately, the goals are to provide a stable occlusion in harmony with the muscles of mastication and the TMJ, to achieve good esthetic results, and to create an occlusal scheme that improves function.

A maxillary removable partial denture can be fabricated with occlusal patterns similar to those of the fixed restorations if it is compatible with mandibular tooth position and anatomy. Create a flat acrylic or metal table to achieve stable contacts in both centric relation and habitual position. Use an overlay removable partial denture if the VDO is increased. Various authors have suggested the use of an anterior deprogramming device to locate a new VDO and permit posterior tooth extrusion in order to establish interarch contact. Another suggested method is to reduce the length of the mandibular incisors and restore the maxillary incisors to provide a stable anterior guidance. An occlusal device similar to the one used for deprogramming may be used to economically and provisionally provide a stable occlusion, as suggested by Dawson. It should be remembered that the treatment of choice is early recognition and successful orthodontic therapy.

SUMMARY

An evidence-based restorative protocol for the treatment of patients with skeletal Class II malocclusions in need of major restorative rehabilitation has been presented. The advantages of this approach are that no irreversible procedures are initiated until the patient is comfortable and the treatment results are visualized clearly. After a harmonious physiological relationship is obtained, treatment becomes technical. Experience has demonstrated that this protocol can successfully restore patients with severe skeletal Class II jaw relationships. Frequent use of an occlusal device to locate the most harmonious deprogrammed position of the mandible has proven to be beneficial in full-mouth reconstruction of patients with Class I occlusion. This technique also has been useful for patients with muscular incoordination.

We extend special thanks to Harry C. Lundeen, DDS, Charles H. Gibbs, PhD, Clyde H. Schuyler, DDS, and Peter E. Dawson, DDS, for their contributions to the dental literature that provided us with direction and inspiration.

REFERENCES


