

# A D E P T

R E P O R T

Volume 4 • Number 1 and 2

Winter and Spring • 1993

## IN THIS ISSUE . . .

Joint/Tooth Positions	1
Jaw Movements	2
Border Positions	2
Horizontal Border Movements	3
Cusp Types	3
Normal Temporomandibular Joint Anatomy	4
Pain and Abnormal Wear Patterns	4
Anterior Wear	4
Abnormal Joints and Dentitions	5
High Dental Restorations and Occlusion	5
Goal of Occlusal Treatment	6
Leaf Gauges	7
Equilibrating the Occlusion	8
Splint Therapy	10
Sequence of Occlusal Reconstruction	12
Informed Consent for Occlusal Treatment	13
What is Occlusal Equilibration?	14
References	15
Frequently Asked Questions	15
The Bottom Line	16

Published By

A D E P T

I n s t i t u t e

P.O. Box 5433 / Santa Rosa, CA 95402

## BASICS OF OCCLUSION

This issue discusses evaluating and treating the occlusion of patients with abnormal wear patterns, abfractions, limited opening or range of jaw movement, and/or occlusal damage which can be treated with occlusal equilibration.

In many cases, establishing the occlusion is the first necessary step in dental restorative treatment, whether major or minor.

This discussion is limited to patients who have 1) joints which are capable of a normal range of jaw movement without muscle splinting, 2) joints which can be comfortably closed into centric relation, and 3) no joint pathology or internal derangements.

We will discuss differentiating patients with occlusal pathology. However, treating patients with disc or joint damage is beyond the scope of this discussion. These patients should be treated by a specialist in this area.

There will be recommendations and a treatment sequence to establish a healthy, functional, nondestructive, relationship between the teeth, the joint, and the related muscles.

### Joint/Tooth Positions

We feel the best starting point for diagnosis and treatment is with the condyle in its fully seated most superior position in the fossa. We will elaborate on our reasons for this belief later in this issue (while acknowledging that the healthiest position for

the condyle in the fossa is controversial).

Here are some important terms in occlusion.

*Centric occlusion* (CO) is the position of the mandible where the teeth are in maximum interdigitation. It is also called the intercuspal or habitual position. This position is based on the *teeth* position.

*Centric relation* (CR) is the jaw position when the condyles of the mandible are in the most superior and anterior position of the glenoid fossa. In this position the condyles contact on the discs or the temporal bones which rest against the articular eminences. This position is based on the *joint* position and is not effected by how the teeth interdigitate.

We believe centric relation is the *most reproducible* starting point for a healthy, balanced occlusion and that, if possible, centric occlusion should occur in this position, especially if a major dental reconstruction is planned. No other point of reference is as consistently reproducible.

In some patients, particularly those with loose joints, a long centric zone rather than a centric point may be required. In these patients the needed space can be as little as .2-.3 mm.

In about 90% of the population there is a discrepancy between the position of maximum intercuspation of teeth and the centric relation position of the joint. This can be demonstrated by the position the teeth first contact when the jaw is in centric relation (called the *retruded contact position* of teeth) and the position of

## Editor

Harry F. Albers, DDS

## Associate Editor

Jerry Aso, DDS; Portland, OR

## Editorial Advisors

Radcliffe Eastman, DDS; Auburn, CA  
 Brian Faber, DDS; Seattle, WA  
 Tom Fasanaro, DDS; Pleasant Hill, CA  
 Jon Luhman, DDS; Sunnyvale, CA  
 Lee Mlejnek, DDS; Lafayette, CA  
 Leslie Plack, DMD; San Francisco, CA  
 Richard Schwartz, DDS; San Antonio, TX  
 Jim Simon, DDS, MEd; Santa Rosa, CA  
 Edward Swift, DMD, MS; Chapel Hill, NC

**ADEPT Report** is published quarterly by the **ADEPT Institute**. Information in this newsletter is based on the clinical experiences and evaluations of the editors, study group graduates, and published scientific research.

The primary purpose of **ADEPT Report** is to act as a supplemental and updated information source to dentists who have participated in advanced continuing education programs on the principles, techniques, and uses of esthetic and bonded restorative systems.

© Copyright, 1993

**ADEPT Institute**

All rights reserved.

**No unauthorized duplications, copies, or citations may be made, by any means, without prior written permission from the publisher.**

Printed in the USA.

## Subscription Information & Address Changes

\$64 for OneYear (Foreign add \$6 for Airmail)

U.S. funds only.

To Subscribe Mail Payment to:

## ADEPT Report

Post Office Box 5433  
 Santa Rosa, CA 95402-5433 USA  
 FAX: 707-575-4033

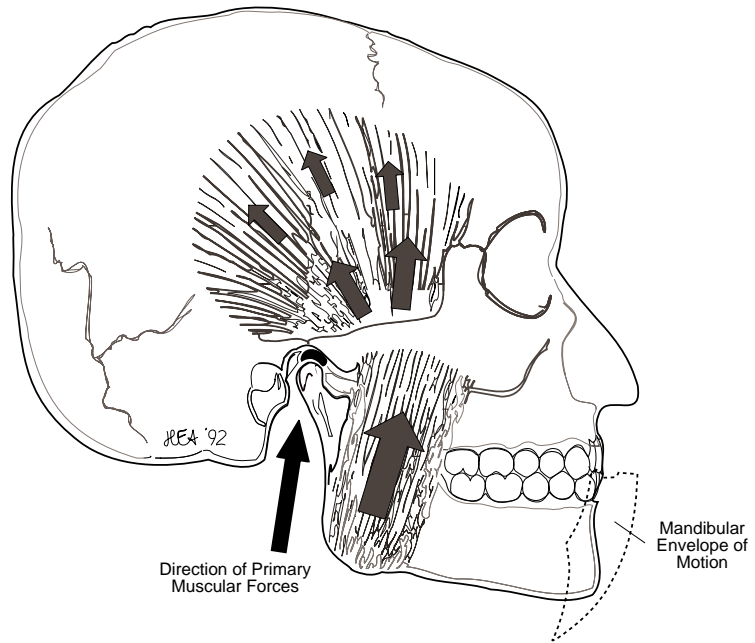


Figure 1: Illustrates the major muscles of jaw closure and the combined direction of the force that they apply to the temporomandibular joint. The position of the occlusion envelope of motion is shown in relationship to the skull and these muscles.

the teeth in maximum interdigitation. In other words there is a discrepancy in the joint between where the teeth have maximum interdigitation and centric relation (called a *CR/CO discrepancy*). Centric occlusion is most commonly anterior to centric relation.

When restoring a mouth there are two alternatives related to occlusion: to leave the patient's centric occlusion unchanged, which is an *unorganized* occlusion; or to alter the patient's centric occlusion so it equals centric relation, which is a *reorganized* occlusion.

An asymptomatic patient can be left in an unorganized occlusion if there is no pain or damage to the dentition and the patient functions comfortably.

## Jaw Movements

*Functional movements* of the mandible include movements during speech, mastication, and swallowing. These occur within the limits to which the jaw can move, called *border movements*. The limits of motion are determined by the joints, their ligaments, and the masticatory muscles.

Learned neuromuscular patterns, called *parafunctional movements*, can become habitual and unconscious. Parafunctional movements include clenching (nonproductive vertical tooth contact), bruxism (nonproductive horizontal tooth contact), and soft tissue biting. These movements are generally not associated with pain other than occasional muscle spasms from excessive muscular activity or from teeth which are traumatized (e.g. abfractions).

*Dysfunctional mandibular movements* are abnormal movements caused by damaged components of the masticatory system. They are often caused by articular disc derangement, frequently from trauma, which can result in clicks, pops or abnormal jaw movements. They are commonly associated with pain and a limited range of movement. This should be treated by one trained in this area.

## Border Positions

In 1952 Posselt described border positions as an envelope of motion (Figures 1 & 2). The envelope is generally viewed from the sagittal plane although it can be

constructed into a 3-dimensional pattern.

The following terms describe the points in this envelope of motion.

The *retruded axis* is the vertical axis on which the mandible can move when in the retruded position. When the mandible hinges up from its retruded axis position with the condyle fully seated in the glenoid fossa, the first tooth contact is the *retruded contact position*.

*Intercuspal position* or *centric occlusion* is the mandibular position in which the teeth are in maximum intercuspation. This is the most reproducible relationship between the arches when only models of the arches are available. It is most commonly used by general dentists, orthodontists, and laboratory technicians to interdigitate the models of the arches based on the wear facets.

Unfortunately, restoring a mouth or even placing relatively simple restorations to this position has caused many iatrogenic problems. It often takes an already compromised occlusion and places cusps or ridges which create new premature-rities.

*Rest position* is the position in which the mandible is at rest without tooth contact. The space between the teeth at this position is called the *freeway space*, *interocclusal distance*, or the *vertical dimension of rest*. This position varies but is generally 2–4 mm vertical to the intercuspal position. It can be measured as the difference in vertical height between two arbitrary points on the midline of the face when the patient moves from intercuspal to the rest position.

As the mandible opens from the retruded position, the condyles translate forward and downward to a *maximum opening*.

### Horizontal Border Movements

During normal lateral movement one condyle rotates (called the *working side*) and the other translates (called the *nonworking* or *balancing side*). During lateral

## Mandibular Envelope of Motion

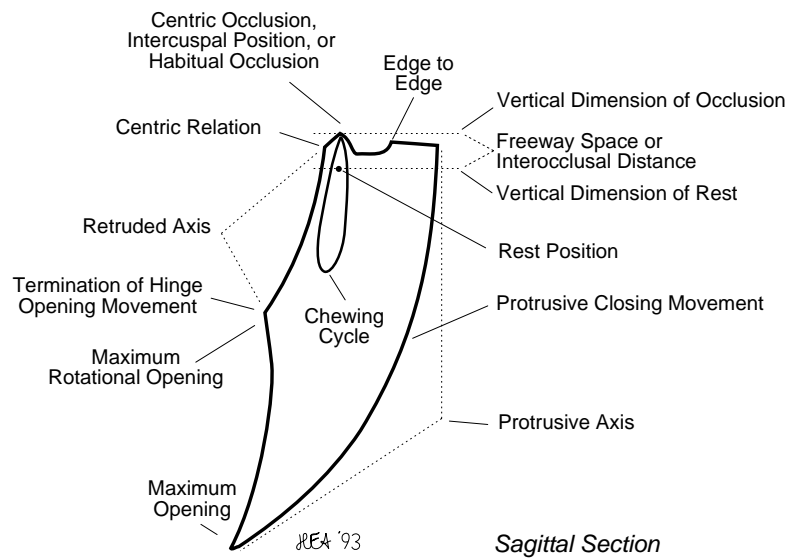


Figure 2: Occlusal envelope of motion from a horizontal view. (The point of reference is the midline of incisal edges of the lower anterior teeth viewed from the side, a lateral view 90° from midline.)

movement the rotating condyle may immediately or gradually shift toward the working side.

These shifts, when they occur immediately on opening or even when the teeth are still in contact, are called *immediate* or *early side shifts*; if they occur gradually during translation they are *progressive side shifts*.

Together these are called *Bennett Movements*, which refer to a bodily shift of the mandible toward the working side before or during rotation.

*Clinically*, this shift is the amount of "slack" in the ligaments of the temporomandibular joint. When the patient chews, especially something tough or repetitive, the muscles will use this horizontal slack, which ranges from 0-4 mm or more, and shift the jaw toward the working side. (Patients with large side shifts seldom chew gum for a long time due to muscle tiredness. If they chew at all, it is for the flavor.)

*Anatomically*, immediate and progressive side shifts are explained by the origins of the pterygoid muscles which are medial to the condyle so when they con-

tract, they pull the condyle medially. If the condyle is not against the medial wall of the fossa, an *immediate side shift* occurs. A *progressive side shift* is simply the condyle following the anatomy of the medial wall as it translates.

Interferences on the chewing side are *working* interferences, and if they are on the nonchewing side they are *nonworking* interferences.

A patient with an excessive wear pattern should be evaluated for these interferences.

### Cusp Types

In a normal occlusion the maxillary lingual cusps and the mandibular facial cusps are called *functional* or *supporting cusps* because they contact the fossa of the opposing teeth and do the chewing. They establish the horizontal and vertical location of the intercuspal position.

The other cusps are *nonfunctional* or *nonsupporting cusps*. The horizontal overlap of the upper teeth keeps the cheek from being bitten while the horizontal overlap of the lower teeth keeps the tongue from being bitten.

## Normal Temporomandibular Joint Anatomy

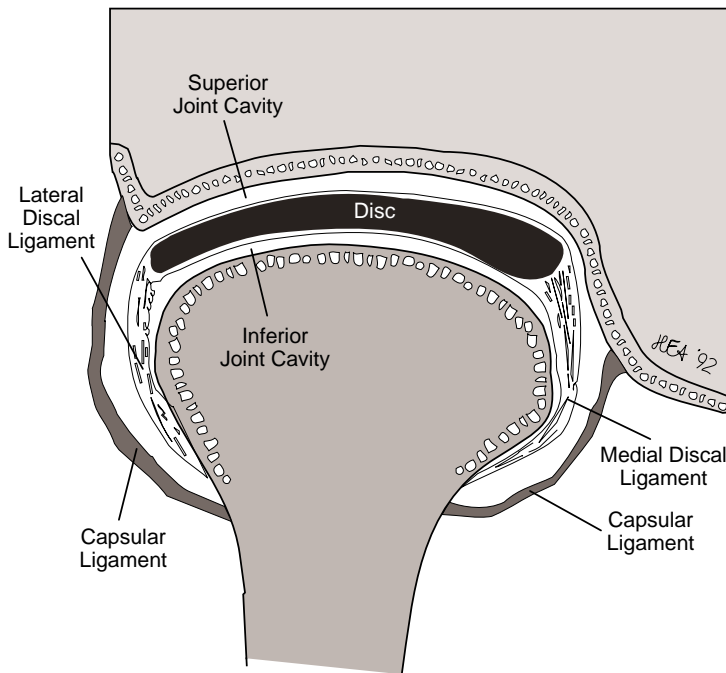
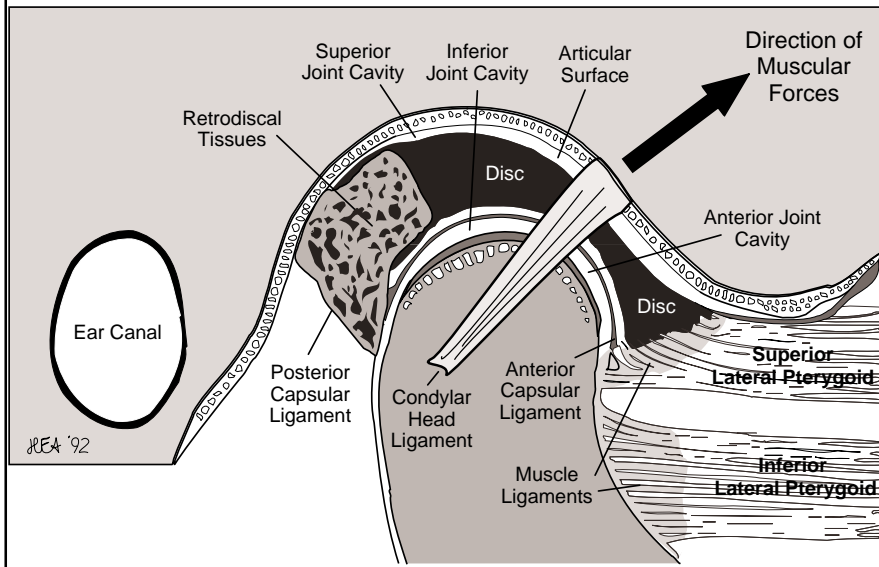


Figure 3: These two illustrations review the anatomy of the normal temporomandibular joint. It is by far the most complex in all mammals. In humans, it has the largest range of movement, the most sensitive proprioception, and is the most easily damaged.

Note the relative positions of muscle attachments to the disc in the upper illustration. It is not difficult to imagine how muscle spasms from stress related disorders could interfere with the delicate components of these structures.

## Pain and Abnormal Wear Patterns

A patient who has damaged the teeth frequently feels little or no pain until the damage encroaches on the pulp chamber, even though the joints may also be damaged.

The most obvious symptom to a dentist of a dysfunctional and destructive occlusion is abnormal or excessive tooth wear. Study group experience over the past ten years indicates that this abnormal wear occurs when the muscles shift the jaw to avoid excessive occlusal force on a few, particularly posterior, teeth. The result is abnormal wear on the other teeth.

For example, we have seen that the avoidance response to a posterior interference (which is especially painful because of the powerful forces generated by the muscles of mastication) may force the occlusion to a protrusive position which can abrade a mandibular central's height from approximately 9 mm to only a few millimeters.

## Anterior Wear

Much of this anterior wear can be demonstrated with before and after models of a dentition where a molar crown (with interferences) was placed. Models taken only a few years later show advanced anterior wear. When the casts are mounted in centric relation the cause of the anterior wear matches the occlusal deflections because of that crown. We have seen hundreds of such cases. Restoring the anterior teeth without correcting the interference will make these restorations short lived.

Over the past 15 years I have had numerous referrals where anterior restorations have failed in a short time. The material is frequently blamed. On many occasions I have adjusted the occlusion and then replaced the same restoration without breakage. In my own clinical cases where breakage occurs I can generally locate an occlusal component, that when removed, has made the same restoration successful. ■

---

## Abnormal Joints and Dentition

Normal joint anatomy is illustrated in Figure 3.

**Condylar Head Ligament.** A defective ligament could distalize the condylar head into the fossa. This is called *subluxation*. Pain or discomfort when using a leaf gauge (to be described later) could indicate a worn or torn condylar ligament. With these patients it is not difficult to overretrude the condyles into the highly vascular and sensitive retrodiscal tissues.

Ideally the condylar head ligaments should be tight to avoid distalization when using a leaf gauge. If there is pain when using the leaf gauge consider a referral to rule out internal derangements of the joint. If none exist, proceed slowly with a splint before making permanent changes to the occlusion.

**Abnormal Radiograph.** Radiographs of the joint can show defects but the absence of defects on a radiograph does not indicate a normal joint. A number of soft tissue defects are not detectable on film.

**Excess Lateral Mobility.** Joints which have excess lateral mobility are difficult to treat. The patient may need to be placed on a

splint until a position which is both stable and comfortable can be reached. This condition may require hand manipulation when taking the final interocclusal records for mounting.

**Abfraction.** The chewing cycle has a horizontal component. If this force is localized on just a few teeth, the teeth may flex horizontally and cause V-shaped defects where the short crystalline enamel rods at the DEJ fracture off at the Class V position, usually on the facial since the chewing forces cause the facial surface to flex. These defects are called *abfractions*.

At one time these were thought to be caused by toothbrush abrasion. However, our study groups have documented that malocclusion initiates and enlarges these defects. Checking the occlusion on a tooth with an abfraction to feel and see fremitus will clearly indicate if occlusion is a causative factor.

**Limited Opening.** Amount of maximum opening that the mandible can be opened from the maxilla (average is 40-45 mm).

**Lack of Anterior and Cuspid Guidance.** The purpose of anterior guidance in this occlusal scheme is to

guide the dentition to disclude on the central incisors as soon as the lower jaw moves anteriorly (protrusively). In addition, any lateral movement of the mandible should immediately disclude on the cuspids (this is *cuspid guidance*). This protects the posterior teeth from nonproductive contact and premature wear.

In some arches disclusion includes the premolars and occasionally the molars. This is *group function*. However, even in group function the cuspid should carry most of the force of disclusion.

In order to do this there should be adequate (3-4 mm) overbite and an acute angle between the mandibular and maxillary centrals of around 15 degrees. The mandibular incisors should contact the lingual surfaces of the maxillary centrals at this acute angle so when the jaw slides forward protrusively, the posterior teeth open almost immediately.

This is a good starting point for the provisionals. In some patients it may be necessary to increase the angle slightly but that can be done during the adjustment phase. ■

---

## High Dental Restorations and Occlusion

High molar crowns are the most common iatrogenic cause of a disrupted occlusion. (Another cause is an improperly finished orthodontic case.)

A crown which is either high in centric occlusion or interferes in side shift can force the jaw to shift to one side. The combination of a midline shift and one arch contacting prematurely can trigger muscular activity which can result in avoidance movements which cause abnormal tooth wear.

Left uncorrected the adjacent teeth in that arch may supererupt so the patient could have contact on only

one side in centric relation. Most patients are unaware of this and report no symptoms because the muscles have adjusted to the occlusion.

It is common to attempt to correct associated anterior wear with bonded materials. However, with the occlusal cause (often undetected by the dentist) still present these restorations generally fail in a relatively short time. Without occlusal correction, replacing the failed anterior bonding with a crown will usually complicate the anterior wear by forcing the patient to shift from the posterior deflection to other teeth.

**How to avoid placing high crowns.** When there is doubt about the centric relation position, use the leaf gauge to reestablish this position. Then the correct occlusal height can be checked with shim stock placed on the teeth on either side to confirm that there is contact with light biting forces. If the patient has been anesthetized, schedule a return visit to confirm the occlusion.

If the crown is a second molar, also check for interferences from Bennett Movements. ■

## Goal of Occlusal Treatment

Although no single occlusal treatment will work on everyone, our experience has shown the procedures outlined here will help most patients.

### *Involving the Patient*

Explain to the patient that the healthiest position for the lower jaw is when:

- 1) Both joints are fully seated in the joint socket and the jaw is centered from left to right.
- 2) At this jaw position, all the teeth should mesh together simultaneously.
- 3) When the teeth come together, they should not force the joint out of this position.
- 4) When the jaw moves either forward or sideways the anterior teeth should guide the movement. The posterior teeth should not interfere with the jaw movement in any direction.

### *Goal of Treatment*

The first goal is to achieve centric relation, which is the position of the teeth when the condyles are in the most centered, superior, and anterior part of the fossa. (Dawson, Dyer, Roth). The condyles cannot be retruded or moved anteriorly from this position without moving inferiorly.

When the patient's teeth, jaws, and muscles function normally, centric relation is not a strained position. But if the teeth do not habitually fit there, closing a patient to this position can be difficult because the musculature may be programmed to close where the teeth fit, regardless of condylar joint position.

Not all patients whose occlusion and joints are out of centric relation need treatment. Many patients with occlusal discrepancies are asymptomatic and do not display marked dental wear.

Patients who cannot tolerate centric relation discrepancies, that is, they have pain or notable tiredness in the masticatory muscles and liga-

ments, or who exhibit marked wear patterns, should be treated.

### *Signs and Symptoms of Joint Problems*

The typical signs and symptoms of occlusal problems which may require treatment include, but are not limited to:

- Myofacial pain of head and/or neck.
- Muscle splinting during jaw hinging.
- Excessive occlusal wear of posterior teeth.
- Atypical incisal wear of anterior teeth, particularly the cuspids.
- Chronic unilateral chewing patterns.
- Tooth mobility.
- Fremitus during occlusal contact or movement, especially where there is enamel fracture in the Class V area.
- Tooth fractures.
- Temporomandibular joint sounds.
- Limitation of jaw opening or movement.
- Unilateral mandibular tori.

In patients with normal occlusion these signs and symptoms are usu-

ally not present. The ability to adapt varies enormously even in the same person at different stages of their life. Dr. Ronald Roth says, "Patients do not adapt to occlusal interferences, they tolerate them; but they tolerate them less well as they get older."

### *Preventive Care*

The key to success is detecting and treating potential problems before they become symptomatic. The time and opportunity to do this is when restorative procedures are done since the design of these restorations depends on the occlusion. The goal is to optimize the occlusion to minimize future occlusal problems.

A patient's stress level can affect the overall ability to tolerate occlusal interferences. Stress is related to a number of disorders including ulcers, migraines, nervous disorders, and of course, bruxism. For many patients bruxism is a primary outlet for stress.

In a patient with occlusal interferences, the teeth and jaw are a likely focus for venting stress. In these patients occlusal interferences can add more insult to an already injured situation. These patients may need continued treatment and appliances to prevent further self-injury. ■

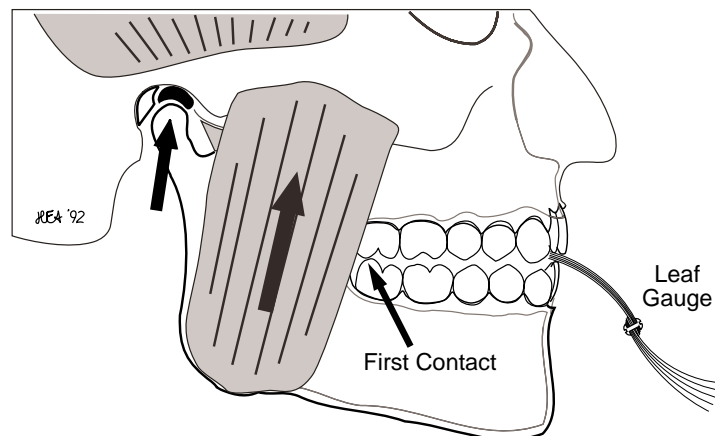


Figure 4: Illustrates the use of the leaf gauge to determine the point of first contact in centric relation.

## Leaf Gauges

Maintaining the condyle in the fully seated position is very important in occlusal adjustment. The leaf gauge maintains anterior, non-tooth guidance during adjustment so the condyle can be positioned repeatedly and consistently. Since the gauge is at an angle relative to the occlusal plane (see Figure 4), closing the jaw places the condyles in a posterior and superior position. The gauge is designed to prevent any contact from the teeth which may cause the condyles to shift out of the centric relation.

Long, in 1973, introduced the use of this gauge to locate centric relation. It is a stack of mylar, metal, or plastic strips each approximately 0.1 mm thick, attached at one end, and numbered so the number of leaves selected can be accounted for (see Figure 4).

A leaf gauge can be made by stacking mylar matrixes approximately 0.1 mm thick, 4-6 mm wide, and 1-3 inches long together and attaching them at one end. A mark with a permanent marker can be placed on every five or ten leaves to help account for the number of leaves used. Use a caliper to measure the thickness of any selected group of strips.

The beauty of the leaf gauge is that it removes operator variability in jaw manipulation. Dr. Richard Schwartz reports having 10 clinicians take 3 interocclusal records on the same patient with leaf gauges. Typically 27 or 28 out of 30 would match. Our experience confirms this. This reproducibility with a hand manipulative technique is unheard of.

### Using a Leaf Gauge

Place enough leaves between the maxillary and mandibular central incisors at the midline so there is no contact on any teeth. Use .0007" mylar articulation marking tape between the teeth and have the patient close gently against the leaf gauge. The force exerted when swallowing is

generally sufficient. There should be no discomfort.

Verify there is no contact by withdrawing the marking tape with the teeth closed on the leaf gauge. There should be neither hold nor drag. Add a few more leaves to insure posterior separation.

The reason for adding leaves is because patients with malocclusion tend to hold their jaw anteriorly. As the muscles relax, the condyle will move upward and backward and the space between the posterior teeth will close. About one-third of patients will feel some muscle stiffness in the TMJ area. This is normal and generally goes away as treatment progresses.

Keep the back teeth separated for 10 or more minutes, or enough time for the muscles to deprogram the adaptation to deflective malocclusion because the proprioceptors in the periodontal ligaments no longer direct the muscles. As the muscles return to their normal physiologic horizontal position, the condyles go to the proper retruded position.

Check the tooth contact again with a thin articulation marking tape between the teeth. If the teeth touch, add more leaves to separate the posterior teeth. Repeat this until the separation of the posterior teeth is stable with the leaf gauge in place. This waiting period is highly variable from patient to patient.

### Mounting the Models

At this position take an interocclusal record so patient models can be mounted for a trial equilibration.

Some prominent clinicians feel that when taking an interocclusal record with a leaf gauge the base of the mandible should be supported in an anterior-superior position to allow for better anterior-superior positioning of the condyle. This can reduce the likelihood of over distalization.

For mounting, a maxillary bite tray should be used which is relined on the upper with bite registration mate-

rial. Compound or wax can be used on the bite trays lingual surface opposite the lower centrals so that the patient's closure for mounting can be repeated to insure accuracy. Once a reproducible position has been located, the bite registration material is added to the over the lingual posterior areas of the bite tray and the patient closes as before into the previously tested position in the compound. Once the lower registration material is set the occlusal record can be used to check the accuracy of poured models and then be used for mounting of the centric relation mounting on the articulator. *Note: the author realizes that there are many ways to take a centric relation mounting and it is beyond the goal of this issue to discuss them in detail.*

Once the models are mounted the initial contact can be seen, usually on the most distal tooth. This is because when the condyle seats, the mandible usually rotates around the distal-most contact. Mounting the case will help demonstrate whether or not the occlusion can be reorganized into centric relation.

A properly taken occlusal mounting is often a startling revelation of adaptation to malocclusion. It is also crucial documentation of the starting point to treatment.

If the patient is about to undergo major reconstruction and the existing restorations are to be replaced, equilibration will not only establish a stable occlusion as a baseline but will also indicate the specific anatomy required in the restorations.

### Indications for Mounting

The following symptoms are indications for mounting models before proceeding with permanent changes to the occlusion. If a patient has a history of TMJ treatment or symptoms, including "locking". If it requires 20 or more leaves on the leaf gauge (2 mm) to clear the first posterior contacts (FPC). In the presence of these symptoms, mounting, and splint therapy are indicated to deter-

mine if the patient can function in the centric relation position. This treatment sequence permits changing the occlusion in a reversible way. (Some patients with joint pathology need to function in an anterior position to hold the disc.)

When the FPC opens the anterior teeth under 1 mm (10 leaves) and the patient is without the

above symptoms, it is generally safe to equilibrate intraorally. Between 1 and 2 mm, clinical judgment and experience dictates the best treatment.

If muscle splinting cannot be reduced so the mandible can be hinged in the retruded position, remove gross occlusal prematurities, use heat, muscle relaxants, or

splint therapy. If all these fail, intercapsular damage should be suspected and the appropriate referral made.

(Some patients may take days or even weeks on a splint for the muscles to relax enough to position the joint in its true hinge.)

## Equilibrating the Occlusion

This is our approach to a full-mouth equilibration. It has provided us with consistent results on a wide diversity of cases.

### *The Objective in a Full-Mouth Equilibration*

The final result of a full-mouth equilibration is harmony of the occlusion with the fully seated, centrally placed condyles in an anterior protected, cuspid-guided occlusion. In centric, the patient should feel absolute simultaneity on closing as each tooth contacts its opposite number at the same instant across the entire arch.

In protrusive function, the four lower incisors should slide smoothly and evenly against the maxillary centrals with no posterior contacts or interferences.

In working movement, the contacts should be heaviest on the cuspids, with lighter contacts on the bicuspid. No other teeth should contact on either working or nonworking sides except in centric.

There should be no working or nonworking posterior interferences when immediate side shift (the Bennett Movement) is initiated. This is discussed below.

### *Rules on Adjusting*

Correction is made by removing occlusal interferences. Selective grinding on teeth follows these rules:

- 1) Generally speaking, take nothing from the cusp tips. This exclusion does not apply to the slopes of the cusp which may be adjusted (See Figure 6). The exception to the rule of not reducing the cusp tip is a plunging cusp which should be reduced and shaped carefully to preserve its function as a cusp.
- 2) Adjustment deepens the grooves, lowers the marginal ridges, and sharpens the cusps.
- 3) The goal is maximum intercuspation and contact of every tooth in the arch.

## Adjusting Centric Occlusion = Centric Relation

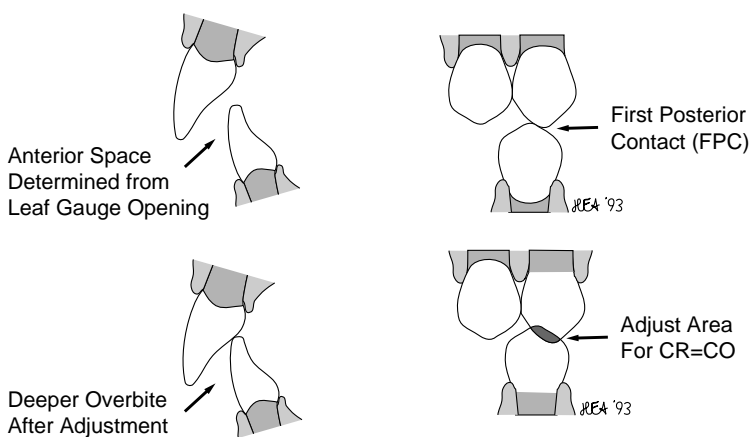


Figure 5: Illustrates a common change in the occlusion of the maxillary teeth when a patient with a large CO/CR discrepancy is mounted in centric relation. When posterior interferences are removed the anterior overbite and overjet are generally increased and anterior contact is restored.

A significant exception to occlusal adjustment is a sensitive tooth or mouth with little or no enamel. This should cause consideration of a full-mouth reconstruction to restore vertical dimension by replacing lost tooth structure.

### *Adjusting Centric Relation*

Anesthetic should not be used during this procedure. The ability of the patient to respond is important. If there are sensitive teeth because the enamel is thin or lost, it may indicate the need to adjust the opposing tooth, to replace restorations or even a full-mouth rehabilitation.

With the leaf gauge in place

throughout the rest period the posterior teeth should still not contact. If they do, add more leaves until the posterior teeth are separated.

Decrease the number of leaves until the point of first posterior contact (FPC) can be detected with the 0.0005" shim stock. Use a hemostat to hold the shim stock to check the posterior teeth.

Mark this contact point with two-color, extra thin (ideally .0007" or less) articulating paper. Deepen the grooves or marginal ridges until the contacts clear. Check all other teeth to insure they are out of contact.

Reduce the leaves one at a time, checking for contact and adjust as needed. As the number of leaves decreases, more teeth will come into contact and should be similarly adjusted. This procedure should continue until:

- 1) Only one leaf is between the incisor teeth
- 2) All the posterior teeth are in uniform contact
- 3) One posterior side is in uniform contact with the anterior teeth.

If condition #1 prevails, the equilibration can continue without the leaf gauge. The redefined occlusion will now support itself in centric occlusion. See Figure 5.

At this point it is helpful to solicit direction from the patient. Most patients are able to direct the dentist toward points of first centric contact and will frequently be able to indicate prematurities at a sensitivity which exceeds the thinness of the marking tape. Patient cooperation of this sort is extremely helpful. It also indicates the degree of precision required.

Using a dual color articulating tape permits seeing prematurities by the colors transferring from the arches. Thus if the first marks are made with red on the upper arch and black on the lower, a second occlusal contact without the paper will superimpose a red mark on the previ-

## Cuspal Adjustments During Equilibration

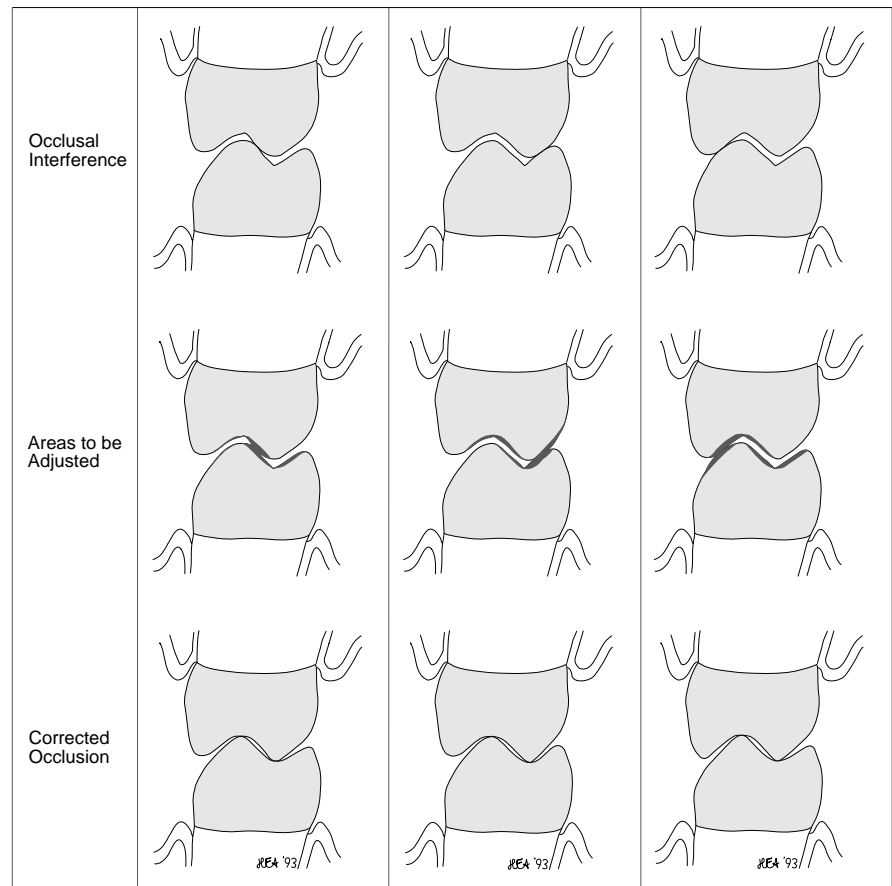


Figure 6: This diagram describes how teeth should be shaped. Note that the cusps become narrower and sharper and the grooves become deeper. If the diagrammed teeth are second molars, there may need to be additional correction to allow for immediate side shift. The dentist should recognize that the steepness of the cusps generally increase from posterior to anterior, the cuspids having the steepest slope which is used to guide lateral movements.

ously placed black, indicating a prematurity at less than the thickness of the marking tape.

In condition #2, the occlusion is an anterior open bite. Either the anteriors need to be restored to the proper length and angulation, or the patient can be left with posterior group function (as in Class II Division I cases unless orthodontics and possible surgery are performed to correct this situation).

In condition #3, unilateral loss of tooth structure has most likely resulted in the need to restore the cusps on the open side. Orthodontics should also be considered.

In younger patients, passive eruption can be very effective. First, measure the number of leaves that separate the non-touching teeth. Then have the patient return in 4-6 weeks and recheck. If the number of leaves decreases each time, self-correction is taking place. If no improvement is seen orthodontics or restorative dentistry may be indicated.

### Adjusting Protrusive Occlusion

With the teeth in the newly acquired centric position, have the patient move the mandible

## Anterior Overbite and Protrusive Movement

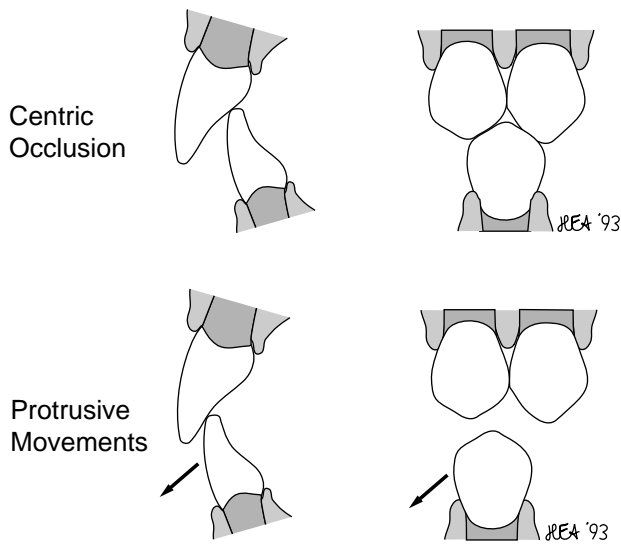


Figure 7: Illustrates the need for adequate overlap (2-3mm) of the upper anterior teeth over the lower anteriors to allow for proper protrusive disocclusion. In all anterior movements of the mandible away from centric relation the anterior teeth should disocclude the posterior teeth. This is one of the reasons anterior teeth are restored first in larger reconstructions.

protrusively. There should be contact on the anterior teeth only, with the four lower incisors moving smoothly and evenly against the two maxillary central incisors. The posterior teeth should disclude immediately. (See Figure 7.) Make adjustments to the linguals of the upper central incisors. No other teeth should contact.

Since the anterior teeth are the most forward to the attachment for the muscles of mastication the forces are less, allowing these anterior teeth to have more sensitive proprioception.

Remove all posterior interferences while protecting centric contacts. Two colors of articulating paper are very useful in making these adjustments. First mark centric in one color, then mark protrusive in another. When the colors conflict in the same spot the centric contact area can be narrowed to allow for protrusive movement.

### **Adjusting the Working Occlusion**

In working, the contacts should be mainly on the cuspids and premolars. If the cuspids are severely worn, restore this critical tooth. Any posterior or nonworking side contact is an interference and should be removed.

### **Adjusting for Immediate Side Shift (Bennett Movements)**

To record the immediate side shift interferences, place marking tape between the posterior teeth on the working side while they are in light contact, press the angle of the jaw firmly in an antero-medial direction, have the patient relax and lightly tap the teeth together. If there are immediate side shift interferences, the patient may wince, which demonstrates why these interferences trigger a deflective response.

Look for these working side shift interferences on the buccal

cusps, on the most posterior lower teeth, and on the palatal cusps on the maxillary teeth, especially if they are crowned. (Patients who complain of an uncomfortable crown which shows no centric prematurities frequently need this adjustment.)

Place the marking tape between the posterior teeth on the nonworking sides, press the angle of the jaw on both working and nonworking sides, have the patient lightly tap the teeth and remove the interferences. Each repetition should be more comfortable.

Typically, a complete occlusal adjustment will take about a 2 to 2-1/2 hour appointment.

After confirming that all positions are correct, dismiss the patient with an appointment in about a week. The time needed for final refinement and to account for some shifting will be approximately 1/4-1/3 the time of the original appointment. At that time, repeat the entire sequence, beginning with the leaf gauge.

The impact of a fully equilibrated occlusion will not be clear until this appointment is complete.

### **Splint Therapy**

When a patient cannot be easily hinged in the retruded position due to muscle splinting, a maxillary stabilization splint may be indicated to allow the musculature to return to a physiologically healthy state so the jaw can be hinged into its retruded position.

The splint should be made on models mounted with a facebow and carefully taken centric, protrusive, and working occlusal records. It should have anterior disclusion and allow the mandible to move freely horizontally with the functional cusps contacting flat occlusal surfaces. (See Figure 8.)

In order to have enough strength to withstand occlusal forces and allow for adjustment, increase the vertical dimension approximately

3 mm. Adjust using a leaf gauge until uniform, simultaneous contact is achieved. Adjust the anterior portion for immediate posterior disclusion in protrusive. There should be no working or nonworking interferences.

As the jaw muscles relax, the position of the lower jaw will change, causing some teeth to strike prematurely. Adjust the splint using the leaf gauge every few days over a period of weeks as needed until the muscles relax and the condyle is fully seated and the centric position marks on the splint do not move.

When this is achieved, the patient is ready for equilibration to make the changes permanent.

In some patients severe muscle splinting may interfere with record taking. In these cases repeat record taking after the patient's muscles have relaxed. Physical therapy, muscle relaxants, and warm moist heat can speed this process.

#### **Adjusting Less Than the Whole Mouth**

A patient may complain of a single tooth which has fremitus,

abfraction, or pain. While it is tempting to simply mark and adjust the tooth, the first step should be to use the leaf gauge because patients will frequently move to an acquired centric to avoid the prematurity. To adjust a tooth to the acquired occlusion may lead to perpetuating a malocclusion. It becomes like adjusting the legs on the proverbial table with one or more legs loose.

Establishing the centric relation should be the first step in any occlusal adjustment, major or minor. When adjusting a single tooth, it is common to find other teeth that require some adjustment.

Always remember, whether the adjustment is to a single tooth or the entire mouth, the rules on tooth adjustment still apply, deepen the grooves, lower the marginal ridges, and remove nothing from the cusp tips.

#### **Patient Management**

It is frequently easier and less stressful for a patient to accept a single fee for treatment, since

this removes a lot of financial uncertainty.

This package fee should be based on an hourly office rate for the average time spent plus 25% for contingencies. This usually results in better patient compliance, higher patient satisfaction, and considerably reduced stress for both patient and dentist.

The fee should include the entire occlusal treatment including a set number of appointments and follow-ups for a specific period, before and after mounted models (when indicated), educational materials, splints, needed replacement restorations, minor postoperative adjustment and whatever else the patient needs. Some offices include a year of follow-up care. State reasonable expectations without guarantees. ■

---

## **Proper Splint Adjustments**

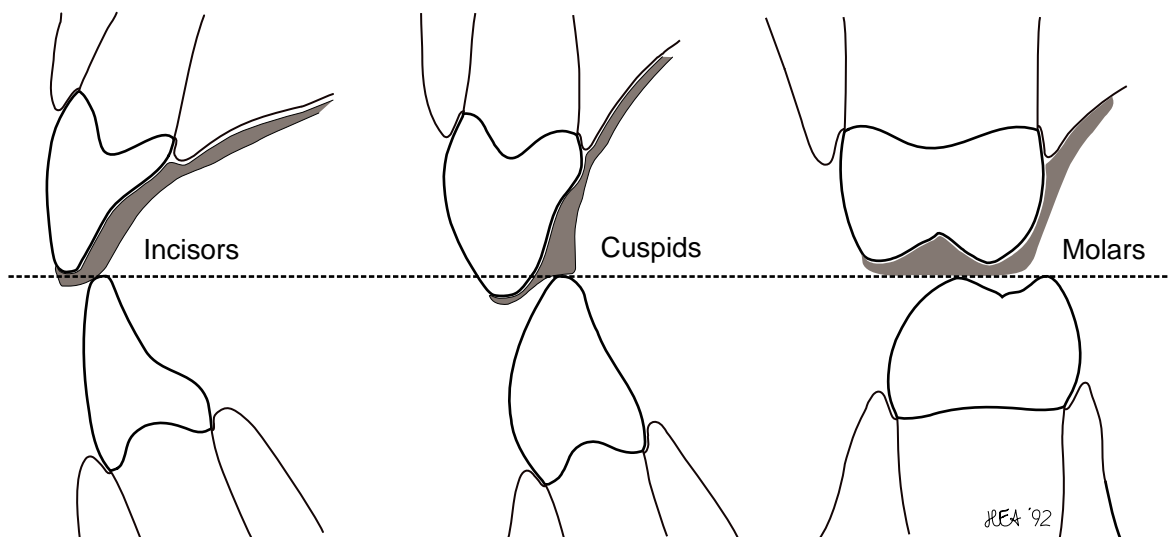


Figure 8: Illustrates the proper horizontal relationship of a maxillary stabilization splint. In all movements away from centric relation the splint should disocclude the posterior teeth.

## Sequence of Occlusal Reconstruction

Since occlusal equilibration is often the starting point for a full-mouth rehabilitation, this section describes one sequence which could be followed for this extensive procedure (assuming a patient without internal TMJ derangement).

### **Vertical Dimension**

Vertical dimension of occlusion is the vertical measurement between the maxilla and mandible when the teeth are in centric occlusion. The minimum distance of vertical dimension is determined by the teeth. However, the maximum vertical dimension is determined by the space the muscles allow which attach the movable mandible to the fixed maxilla. The teeth must be made to adapt to this place. If attempts are made to have the muscles adapt to the restored tooth length, problems usually result.

Correcting vertical dimension is often more complex than replacing worn teeth. Passive eruption of worn teeth may result in limited freeway space. If this space needs to be impinged on, provisionals are necessary to determine whether the patient can comfortably tolerate it.

Generally speaking, vertical dimension should be opened to deal with inadequate interarch space for tooth restorations. The amount of space needed should be verified with a pretreatment wax-up, creating adequate space for optimal restorations and occlusion. This often requires restoring both arches simultaneously.

This method of treating a full-mouth reconstruction, which involves opening the vertical dimension, is designed to accomplish the task in the most predictable way.

### **Phase 1: Establishing Centric Relation and Vertical Dimension**

Use a leaf gauge to establish the centric relation position. Take centric and working check bites and mount the case on a fully adjustable articulator. Wax up the case to establish a suitable vertical dimension with enough room for anterior and cuspid guidance and sharp posterior cusp tips for maximum intercuspation. Use the wax-up as a model to fabricate provisional restorations.

Direct placement restorations, the preferred method of establishing a provisional occlusion, can be bonded to existing teeth and restorations to provide a periodontally healthy and relatively maintenance free provisional occlusion.

All planned occlusal features should be built into the teeth at this point to allow the patient to adapt to the planned changes. Adjustments can be made over a period of weeks until a comfortable and stable occlusion and chewing pattern are established.

### **Phase 2: Opening the Vertical**

When indicated, opening the vertical dimension can usually be done in a single appointment. Begin the provisionals on the anterior teeth by placing direct bonded composite to the lingual surface of a single upper central while the leaf gauge is between the other central. Then light cure. This establishes the vertical position. Then add composite to the other anterior teeth, each time having the patient close to the first filling (check it with shim stock), then light cure while the patient holds this contact. Shape the composites and adjust the occlusion carefully. Then add direct bonded composite to the cusp tips of all the posterior teeth in slight excess. Adjust the occlusion with a leaf gauge until all teeth contact evenly.

### **Phase 3: Restore Anterior Teeth, Occlusion, and Guidance with Final Restorations**

At a subsequent appointment confirm that the occlusion is stable. Take impressions of the provisionals to which the patient has adjusted. Mount the models to make a custom acrylic incisal guide table for the articulator and to show the laboratory technician what the final restorations should accomplish. Prepare the anterior 6 teeth on both arches and have the technician fabricate the restorations. After cementation, use a leaf gauge to verify centric, anterior disclusion, and cuspid guidance.

### **Phase 4: Restore the Bicuspids**

Place permanent restorations on the eight bicuspids. This will maintain vertical dimension and hold occlusal function bilaterally.

### **Phase 5: Restore the Molars**

Generally, patients prefer that these teeth are restored with tooth colored restorations. However, bonded gold restorations with full occlusal coverage and supragingival margins on enamel are the restorations of choice.

Although some clinicians will prefer to restore the bicuspids and molars together (in Phase 4). It may be preferable to wait for a Phase 5 to restore the most posterior molars separately, especially if there is a pronounced side shift.

### **Phase 6: Verify Occlusal Stability**

At three and six months, verify and fine-tune the proper centric relation. If the hinge axis is stable, one or two 0.1 mm leaves of the gauge between the anterior teeth should disclude all posterior teeth when measured with a 1/1000 shim stock. ■

# Place Your Masthead Here

*Your local printer can photographically copy this page, remove the page number and footer below, place your masthead above, and print the front and back sides of this patient-information sheet for use in your dental office.*

## Informed Consent for Occlusal Treatment

### Introduction

Occlusal adjustment is a procedure by which your bite is corrected so the position of the teeth harmonizes with the most stable, balanced position of the jaw joints and muscles.

- This involves removing portions of your restorations and/or teeth.
- Occasionally the amount of tooth or restoration that needs to be removed may require that a restoration be placed or replaced on a tooth.
- The procedure will require two or more visits to complete.
- It can take a few days or weeks for the jaw muscles to become accustomed to the new bite.

### Expected Results

- Because each person is unique, there can be no guarantees as to how long the treatment will last. An occlusal adjustment usually lasts between 3 and 5 years and often much longer.
- Average treatment time is 2 to 6 hours. Difficult cases may require more time.
- The potential for teeth chipping, breaking, and fracturing from nighttime grinding can be greatly reduced by wearing a splint. Patients with high levels of muscular activity should have one custom made for them.
- Sensitivity to cold commonly occurs immediately after treatment. This may last a few weeks or more. It should steadily decrease over time.
- If a tooth or restoration has already been worn significantly, it may not have enough remaining thickness to bring it into proper alignment by adjustment. These teeth may need new restorations.

### Patient Instructions

- As the muscles adjust to the new position there may be some muscle tenderness. This can be treated with hot towels to the face as needed. Mild analgesics such as Advil or the prescription drugs Ansaïd, Anaprox or Motrin may be helpful.
- Inform the dentist immediately if a restoration breaks or starts to be uncomfortable.
- Your dentist should check your mouth in 6 to 12 months to evaluate the stability of your bite.
- Over time the bite may gradually shift and require minor adjustments.

I have read the above. My questions and concerns have been answered and explained to me. I approve the treatment the dentist has recommended.

I also agree to return for periodic oral examinations after treatment is completed. I have received a copy of this information and instruction sheet. I understand the directions and the risks, and I consent to treatment.

I also consent to photographs being taken. I understand they will be used for documentation, treatment study, and for educational purposes.

Patient: \_\_\_\_\_ Doctor: \_\_\_\_\_  
Date: \_\_\_\_\_

*Notes and Special Instructions:*

# Place Your Masthead Here

Your local printer can photographically copy these two pages, remove the page number and footer below, place your masthead above, and print the front and back sides of this patient-information sheet for use in your dental office.

## What Is Occlusal Equilibration?

### **Goal of Occlusal Treatment**

The goal of this treatment is to alter the teeth so they coincide with a healthy jaw position. The ideal is:

- 1) Both joints fully seated in the joint sockets. This is the resting position for the muscles of the jaw joint.
- 2) When the jaw closes, all the teeth mesh at the same time.
- 3) When the jaw moves sideways, only the cuspids and sometimes the bicuspid should touch.
- 4) When the jaw moves forward, only the front teeth should touch.

### **The Problem**

When there is a discrepancy between the positions where the jaw joint is fully seated and where the teeth have the most contact, there is the likelihood of excessive tooth wear, and pain in the muscles of the jaw joint, in the neck and even in the back as the body tries to compensate for the difference. It can also trigger jaw movements like clenching, bruxism (tooth grinding) or soft tissue biting. These movements can be habitual.

These discrepancies frequently center around the back teeth which are in the position where the chewing muscles are most powerful. A strong bite on a malpositioned tooth (or teeth) in this position is sharply painful. This pain forces the jaw to shift, causing wear on other, usually anterior teeth where there is less pressure. Wear is frequently greatest on the cuspids (the eye teeth).

As the anterior teeth wear (sometimes they even get loose), the posterior interferences become more pronounced and the jaw must move further to find a non-painful position. This puts more strain on the jaw positioner muscles.

If left untreated, there may be damage to the joint. This can be recognized by clicks, pops, or abnormal jaw movements. When it reaches this stage, it may be associated with pain and a limited range of jaw movement. It may even result in the jaw "locking". Severe cases may need treatment by a specialist in this area.

### **Symptoms of Joint Problems**

Indications of bite problems which may require treatment include but are not limited to:

- Pain during jaw opening
- Excessive tooth wear
- Chronic chewing on one side
- Tooth movement during chewing
- Tooth fractures
- Joint sounds
- Limited jaw opening or movement
- Head and/or neck pain

Some people have high pain tolerance and can adjust to tooth interferences that will cause pain to others. Some have tooth/joint discrepancies but no pain or excessive tooth wear. Others are pain free even though the joints are damaged and the teeth are worn. Some can tolerate occlusal interferences when they are young but less as they mature. This may be the result of a lifetime of tooth wear and the increased accommodation the muscles must make.

Stress can affect the ability to tolerate occlusal interferences. Stress is related to a number of disorders like ulcers, migraines, and nervous disorders. For many, bruxism is a primary outlet for stress.

If there are interferences to the teeth coming together when the jaw is fully seated, it can make the teeth and jaws a likely focus for venting stress. These people may need continued treatment and appliances to prevent self-injury.

### **Preventive Care**

The key to success is detecting and treating potential problems early. Our goal is to treat the problem before there is either pain or excessive tooth loss.

### **Occlusal Treatment**

When your teeth are adjusted the dentist will use a stack of plastic strips, called a leaf gauge, to keep your teeth separated. The treatment may begin with using this gauge for several minutes to separate your teeth until the muscles relax.

If muscle tightness cannot be reduced so the jaw can be hinged easily, we may

begin by removing gross prematurities, use heat, or a muscle relaxant. If the muscles do not relax, it may be necessary to reschedule the appointment.

During the equilibration the jaw joint will be maintained in a fully seated and stable position using the leaf gauge. This gauge is used to stop the deflection that occurs when teeth contact prematurely and allows the interfering teeth to be marked. The teeth will be adjusted so they will contact uniformly at the correct joint position.

At the end of this appointment, all of the teeth should contact simultaneously and all jaw movements should be balanced and supported. This ideal is not always possible. If this is so in your case, the dentist will discuss what that means to you.

The adjustment will leave you with sharper cusps and deeper grooves on the teeth, which often makes chewing easier. It will not flatten the teeth. No anesthetic will be used. If the teeth are severely worn and become sensitive, the dentist may discuss placing restorations to replace the function on the severely worn teeth.

There will be at least one more appointment to refine the bite because the teeth will shift as they strike in their new positions. Usually, it is not until this appointment is complete that the full benefit of this treatment is known.

### **Splint Therapy**

If the leaf gauge and heat fail to relax the joint, an acrylic splint to fit over the upper teeth may be recommended. This splint removes tooth interferences so the joint can be fully seated and the jaw muscles can return to a normal position. During this time it will be necessary to regularly adjust the splint. Splint therapy may take from several days to several weeks.

If these initial treatments fail to allow the joint to be properly positioned, or if the splint itself triggers pain, it will indicate there is joint damage and a referral will be made to a specialist.

© Copyright 11/1/1993 Harry F. Albers, D.D.S.

## Recommended Reading

- Dawson, P.E.: Evaluation, Diagnosis and Treatment of Occlusal Problems. Second Edition. St. Louis, CV Mosby, 1989. An excellent text covering a broad range of topics concerning the treatment of occlusal and TMJ problems.
- Ramfjord, Sigurd; Ash, Major M.: Occlusion. Third Edition. W.B. Saunders Company, Philadelphia, 1983. A world classic on occlusal problems and their treatment.
- Okeson, Jeffrey P.: Fundamentals of Occlusion and Temporomandibular Disorders. Third Edition. C. V. Mosby Company, St. Louis, 1993. This text is excellent in its review of the anatomy and etiology of functional disturbances. It offers a wide range of treatments for TMJ problems.
- Golsen, Lawrence F., Shaw, Allan F.: "Use of the Leaf Gauge in Occlusal Diagnosis and Therapy". Clinical Dentistry Volume 1, Chapter 7A, p. 1-9, 1992. An excellent chapter on the use of the leaf gauge. Contains many good clinical concepts.

## Bibliography

1. Dawson, P.E.: Evaluation, Diagnosis and Treatment of Occlusal Problems. Chapter 4. St. Louis, CV Mosby, 1974.
2. Kornfield, M.: Mouth Rehabilitation: Clinical and Laboratory Procedures. Vol 1, p. 34. St. Louis, CV Mosby, 1967.
3. Long, J.H.: "Locating Centric Relation With The Leaf Gauge." J Prosthet Dent 29:698, 1973.
4. Mahan, P. E.: "Physiology of Occlusion". In Clark, J.W. (ed): Clinical Dentistry. Vol 2, Chap 33. Philadelphia, Harper & Row, 1981.
5. Williamson, E.H.: "Occlusion and TMJ Dysfunction". J Clin Orthodont 15(5), 1981.

6. Lucia, V. O.: Modern Gnathological Concepts, pp 134-138. St. Louis, CV Mosby, 1961.
7. Mortel, M. H.: "When - Why - How to Adjust Occlusion". Quintessence International. 13(9), 1982.

8. Roth, R. H., Rolfs, D. A.: "Functional Occlusion For The Orthodontist". J Clin Orthodont 15(5), 1981.
9. Roth, R. H., Rolfs, D. A.: "Editorial Interview". J Clin Orthodont 12 (2). 1981.

## Frequently Asked Questions

**Question #1: Should the occlusion be adjusted on a nonsymptomatic patient?**

**Answer:** Pain is not a good indicator for tooth adjustment since pain is a complex phenomena which is related to many factors, most of which are not occlusion related.

Abnormal tooth wear, one side chewing, fremitus with abfractions, or limited range of mandibular movement are indications for occlusal diagnosis and treatment. There is little correlation between the severity of these problems and patient discomfort because patients can accomplish complex avoidance patterns. However, these avoidance patterns may cause tooth damage, often without a patient's awareness.

Thus minor adjustments, through a lifetime to protect the dentition, the TMJ, and facial muscles are recommended. Many anterior wear patterns which require an esthetic repair can be traced to occlusal interferences that have multiplied and caused enough avoidance patterns to damage the teeth.

**Question #2: How do abfraction, erosion, and abrasion differ?**

**Answer:** An abfraction is the result of excessive forces on a tooth (usually seen on the facial but can also be on the lingual). This is usually corrected by occlusal adjustment. Restorations are indicated in very deep lesions.

Erosion is caused by dissolving the tooth with acids and are asso-

ciated with bulimia and other gastric disorders. This generally occurs on the lingual. Diet or dietary habits can cause erosion in other areas.

Abrasion results from mechanically wearing down a tooth, as with improper toothbrushing. These are generally on the facial and correspond to the patient's oral hygiene habits.

**Question #3: What is the best way to initially examine a patient for abnormal occlusal patterns?**

**Answer:** I have had the best result with green occlusal wax which gives me a view of the overall pattern and allows me to direct my attention to areas of concern. Then full-arch red and blue articulating paper can locate the precise areas of concern. The actual adjustments should be marked with extra thin (.0007") pieces of red and black mylar ribbon. The black is used to maintain centric while the red easily distinguishes interferences to be adjusted.

**Question #4: What is the main concern when adjusting the occlusion?**

**Answer:** Maintaining a stable, reproducible, comfortable centric occlusion. If the patient's jaw has very tight muscular control, a reproducible centric may not initially be possible. This may indicate (with a normal TMJ) that the patient doesn't have a comfortable and reproducible centric and the musculature has formed an artificial one to avoid occlusal interferences. These cases require specialized training in the use of splints and other devices

to determine a comfortable centric relation or occlusion for the patient.

**Question #5: In centric should you have contact, light contact or no contact of mandibular anteriors with maxillary anteriors?**

**Answer:** From our experience patients do best when all of their teeth contact evenly in centric at the same time. All contacts are verified with shim stock. When completed, the patient should not be able to determine which tooth touches first. All the teeth should contact simultaneously. Toward the end of the adjustment I continually ask the patient which teeth touch first in centric. When

the response is "None, they all touch at the same time", I know the treatment is nearing completion.

**Question #6: How do you handle a cross bite?**

**Answer:** Our major goal is a good centric relation. Lateral movements may be difficult to allow for in some cases. These cases should be mounted and diagnosed very carefully. Any changes are first done in provisionals. Our main goal is comfort and function. Sometimes the final treatment is unique, but so is the patient.

**Question #7: Why do dentists seem to disagree on occlusion more than any other dental treatment?**

**Answer:** One reviewer wrote

"Occlusion is a fairly difficult topic to discuss because there are so many differing opinions, most of which can't be substantiated. If you get a bunch of 'good old boys' together and talk about occlusion, there is a good chance a fist fight will break out." Other reviewers have made similar comments.

Because occlusion plays such an important part in successful treatment planning, we felt the topic needed to be discussed. Thus we have presented material in this issue which has worked consistently on hundreds of patients. We hope it is a starting point for many dentists. ■

## The Bottom Line

*Editor's Choice of Selected Materials*

### **.0005 " Silver Tape to Detect Occlusal Contacts**

- **0.0005-inch shim stock.** Artus Corporation: P.O. Box 511, Englewood, NJ 07631-0511. Phone: 201-568-1000.
- 0.0005-inch (8 $\mu$ ) shim stock. #G9124, Great Lakes Orthodontics, 199 Fire Tower Drive, P.O. Box 5111, Tonawanda NY, 14151-5111, Phone: 716-695-6254, Outside NY 800-828-7626.

### **Leaf Gauges**

- **Huffman Leaf Gauge;** numbered with 0.1 mm. leaves. Panadent Corp., 22573 Barton Road, Grand Terrace, CA. Phone: 714-783-1841, FAX: 714-783-1896.
- Leaf Gauge; every 8 leaves equals a mm. Great Lakes Orthodontics #GL1701 (3/Pkg.) 716-695-6254, Outside NY 800-828-7626.

### **Articulating Paper**

- **Hanel Marking Ribbon,** .0005" thick, with colors black, red, blue, green on one side. May be folded over for two side marking at once. Panadent Corp: 714-783-1841
- Occlusal Adjustment Kit with red, black, and green articulating paper (with either color on 1 or 2 slides, and 2 clamping tweezers. #G9115 Great Lakes Orthodontics. Phone: 716-695-6254.

- AccFilm II .0007" Articulating Paper, Parkell, Farmingdale, N.Y., Phone 516-249-1134

### **Two-colored Full Arch Articulating Paper**

- **Horseshoe Articulating Paper,** #100-9405, Blue/Red. Henry Schein Inc., 5 Harbor Park Dr., Port Washington, NY 11050. Phone 800-472-4346. This is a thicker two-sided waxed paper and marks well in a moist environment. Accuracy can be improved by having the patient tap once with the paper in and once more with it out. The areas where the colors are transferred to the opposing arch represent the thinness of the wax pigment itself.

### **Articulating Paper Forceps**

- **Posigrip Articulating Forceps** #76-1, Miltex Instruments, 6 Ohio Drive, C.B. 5006, Lake Success, NY 11042, Phone 516-775-7100, 800-645-8000, Fax 516-775-7185. Many manufacturers make articulating paper forceps. Most work adequately on thick papers. Unfortunately, few work with the thinner articulating papers. This brand works better than most others with .0005 and .0007 papers.

- Articulating Paper Forceps #100-5648. Henry Schein Inc., 5 Harbor Park Dr., Port Washington, NY 11050. Phone 800-472-4346. These German made stainless steel forceps have a grooved holding surface that works well with most medium to thick articulating papers.

### **A Small Football Shape Finishing Diamond and Bur**

- **#8368-016:** 40 micron football shaped finishing diamond. Brassler USA, Inc., 800 King George Blvd., Savannah, GA 31419-9598. Phone 800-841-4522.
- **#368-016 3.5F,** 40 micron football shaped diamond. Diatech Diamond USA, Inc. P.O. Box 3388, Drawer H.H., Hilton Head, SC 29928. Phone: 800-222-1851, Fax: 1-803-686-8698.
- #368-020 5F: Slightly larger than the 016. Diatech Diamond (address above).
- #EL1.5: a football shaped finishing diamond available in 50 $\mu$  and 25 $\mu$  grits. Lasco Diamond Products, P.O. Box 4657, Chatsworth, CA 91313. Phone 818-882-2423 and 800-621-4726.
- #023-379F: 12 fluted football shaped finishing bur. Brassler. Phone 800-841-4522.

### **Green Occlusal Wax**

Occlusion indicator #3604-0065 (Kerr)

*Products in **Bold** are those most often used by the editor. This choice does not imply superiority, merely a subjective clinical preference.*