F.V. Celenza

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by Frank V. Celenza,
A.B., D.D.S., M.S.D.

Clinical Professor and Director Section of Occlusion
New York University, College of Dentistry

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Independently published

English version

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Preface

This manual was first published in 1973 under the title, “The Physiological Development of Occlusal Morphology”. The second edition was published in seven languages in 1975. This third edition has several changes and additions which should add to the value of this teaching technique. First of all the original title was too cumbersome. While it was descriptive of the contents it was much too pretentious for a teaching manual. It is therefore changed to “Occlusal Morphology” in this edition. The changes in terminology are in effect a plea for a more scientific language in describing mandibular movement. The present use of the terms “working side” and “balancing side” is misleading. The working side implies that the other side is not working. The balancing side implies imbalance on the other side. The terms ipsilateral and contralateral, while new to some of us, have been used successfully in the scientific literature for many years.

The introduction has been expanded to include more detail on the posterior and anterior determinants. Special emphasis on the controversial role of the anterior determinants will clarify this function for the student. Detailed description of the locations of the centric contact points in each style of occlusion will be drawn by the student which will test his comprehension of the exercise.

All of the drawings in this manual have been drawn to scale according to average measurements. An example of the importance of this approach is in the placement of the mesio-buccal cusp of the mandibular first molar. Many teachers place all three buccal cusps so that they articulate in the three fossae of the maxillary first molar. This has always been difficult to do without a great deal of distortion of both teeth.

The mandibular posterior teeth are mesial to the maxillary

teeth because of the lesser mesiodistal width of the mandibular anterior teeth. This difference begins to decrease due to the usual distal relation of the mandible to the maxilla and the greater mesiodistal dimension of the mandibular molars. The alignment finally even out at the distal of the opposing third molars. Since the mandibular first molar is mesial to the maxillary first molar and also is one millimeter longer mesio-distally, how would it be possible to fit all three buccal cusps into the opposing three fossae of one tooth? The mesio-buccal cusp of the mandibular first molar is therefore more comfortably articulated with the distal marginal ridge of the maxillary second bicuspid and the mesial marginal ridge of the maxillary first molar.

New models for the equilibration exercise (Exercise III) have been constructed in epoxy material. By utilizing abrasive white te stones for occlusal adjustments, the student gets the “feel” of a clinical situation not possible with stone models and with less expense than denture models.

A brief section on the practical application of techniques has also been added. The waxing method has been helpful in giving the student a sequence that can be basic to his own personal inventiveness when he becomes more experienced.

Beginning students should concentrate on learning the principles rather than attempt to master a technique. For this reason it is advised to have them concentrate on two teeth (second bicuspid and first molar) in the arch for both waxing exercises rather than attempt the entire arch at the first exposure. This also places less of a demand on curriculum time.

This manual is designed to help the student gain intimate insight and knowledge in all three anatomical styles of occlusion. Understanding all three should add versatility to the armamentarium of the practitioner rather than a blind adherence to one concept which cannot be applicable to all conditions.

This is a teaching manual and as such does not pretend to contain all the information on the subject. There are many opportunities for instructor elaboration. Handled correct-

ly this method of teaching the subject of occlusion can be the most meaningful and rewarding vehicle of an occlusion course.

The drop-wax add-on technique was introduced to the dental profession by Dr. Everitt V. Payne. His technique was later modified and taught by Dr. Peter K. Thomas. Dr. Harry C. Lundeen color coded the system and pioneered the teaching of occlusion in the undergraduate curriculum. This has been expanded by Dr. Rex Ingraham and Dr. Arnold Weissgold to include a more comprehensive view of the subject. Dr. Peter E. Dawson has been most helpful in emphasizing the importance of the anterior components.

The pioneering efforts of Dr. Niles Guichet were instrumental in exposing the profession to a more clarified view of the science of occlusion. The way was paved earlier by Dr. Anthony DePietro and of course originally by Drs. Beverly McCollum, Harvey Stallard, and Charles E. Stuart.

I have attempted to draw from the knowledge of these teachers and assemble, modify, and present what I sincerely hope is an improved and comprehensive approach to teaching this aspect of the subject. In this regard I must thank my teachers, the late Dr. Ernest Granger who introduced me to the field, and most especially Dr. Victor O. Lucia who literally took me by the hand and guided me through those difficult early years as my teacher, mentor, and good friend.

Credit for all the artwork must go to Ms. Ilsa Parr. Her tireless energy and suggestions were essential to the construction of this manual.

Finally, to Dr. Alain Roizen goes the credit for organizing, editing, and in general just making certain that this book was done. Without his efforts this book would never have been written and I am sincerely grateful to him.

Terminology

Ipsilateral Side: This is the side toward which the mandible moves in a lateral excursion from maximum intercuspation toward an eccentric position.

Ipsilateral Condyle: The condyle on the ipsilateral side. This is the condyle closest to the rotary center.

Contralateral Side: This is the side away from which the mandible moves in a lateral excursion from maximum intercuspation toward an eccentric position.

Contralateral Condyle: The condyle on the contralateral side. This is the condyle farthest from the rotary center

Cusp ridge: The mesial and distal slope of the cusp which extends from the cusp tip to the marginal ridge.

Outer aspect: The central portion of the cusp ridge. It extends from the height of the cusp to the occlusal third of the buccal or lingual surface.

Inner aspect: The central portion of the cusp which extends from the tip of the cusp toward the central part of the occlusal surface. This is also called the triangular ridge. The base of the triangle is the central fossa; the apex of the triangle is the cusp tip.

Basic Principals

The study of occlusion encompasses three specific elements. These are the temporomandibular joints, the neuromuscular mechanisms, and the dental units. These elements are coordinated into one unique and intricate system which is expressed by opposing tooth contacts. A purpose of this manual is to point out the interrelationships that exist between these elements.

The articulator represents the paths of motion permitted by the physiology of the system and the occlusal surfaces are anatomical expressions that result from the motion. The student will gain an appreciation of the dynamics of articulation by relating the anatomy to physiology.

The purpose of the waxing exercises is to aid in explaining the physiology of the system and develop a procedure for a treatment occlusion. It is not an attempt to explain or duplicate natural tooth anatomy.

The first exercise was designed to point out the limitations of restoring to a pre-existing occlusion. The dentist is confronted with this situation the majority of the time in clinical practice.

The second exercise does not limit the articulation scheme to a given form. It allows the student to work surface against surface and alter the anatomy to suit the physiology with more freedom and precision.

The third exercise is not a waxing exercise but a grind-in procedure. The student will apply his knowledge from the waxing exercises to the grind-in technique and learn the limitations of occlusal adjustment.

Occlusal determinants

The two main determinants of occlusion are the posterior and anterior determinants. The posterior determinants are dictat-

ed by the temporomandibular joint border pathways. The essential motions involved are three-dimensional rotations and horizontal translations (the Bennett movement). This may be regarded as a fixed determinant which is given by the temporomandibular joints through registrations of the motion at that time. This information can be transferred to the articulator in the form of condylar settings.

The anterior determinants are those guide angles formed by the lingual surfaces of the maxillary incisors and cuspids as they articulate with the opposing mandibular anterior teeth. This determinant is not fixed and can be altered somewhat by modifying the lingual concavity of the maxillary anterior teeth. The anterior determinant is called the anterior guidance and can be reproduced on the anterior guide table of the articulator. The essential motions in this determinant are vertical and horizontal rotations combined with translation. In prosthetically created dentitions, coordination between the anterior and posterior determinants is desirable to avoid traumatic relations of the temporomandibular joints. In this way, the resulting occlusal forms will be accurate expressions of both determinants.

The anterior guide angle can be defined as that contact relation of the anterior teeth as determined by the incisal guide angle in protrusive excursions (vertical rotation plus translation) and the cuspid guide angle in lateral excursions (horizontal rotation plus translation). Anterior guidance is the combined effect of these two angles. Posterior teeth may have to serve the function of anterior guidance when there is no anterior tooth contact.

Condylar guidance is the combined effect of all the rotations and translations in the condylar determinant. Condylar guide angles combined with the anterior guide angles in the same plane will influence the cusp angulation and resultant motion in a given style of occlusion. For example, a protrusive excursion is affected by the sagittal condylar guide angle and the incisal guide angle. Posterior occlusal surfaces in contact in this movement must be harmonized with the combined effect of these two determinants in order to maintain the relation. The closer a cusp to a determinant, the more the cusp angle will

approximate the determinant angle. The cusp angle midway between the two determinant angles will equal the average of the two if the occlusion is balanced in the excursion. If balance is not desired, the cusp angle midway must be less than the average of the two determinant angles. If the midway cusp angle exceeds the average of the two, it is in a premature contacting relation. Traditionally, all of these angles are measured with the Frankfort horizontal plane.

Two essential principles are important in designing the occlusal forms of teeth. First, the condylar determinants should be incorporated into the scheme so that any motion, of the mandible will not traumatize or disarticulate the joint. The second principle is to attempt to create occlusal forms that secure the position of maximum intercuspation as the most closed position. All eccentric motions from the intercuspal position should require opening rotations of the mandible. This is the usual direction of movement on the articulator. The importance of this arrangement is to allow a continuance of elevator muscle activity as the mandible moves from an eccentric position toward the centric position during mastication. In addition, the position of maximum intercuspation has greater mechanical stability when it is the most closed position.

In order to satisfy these requirements it is preferable to have the anterior guide angles exceed the numerical value of the condylar guide angles. When the anterior guide angles are greater than the condylar guide angles, the anterior guidance is positive. All movements from the position of maximum intercuspation will require opening rotations of the mandible. When the anterior guide angles are equal to the condylar guide angles, the anterior guidance is zero. When the anterior guide angles are less than the condylar guide angles, the anterior guidance is negative. This appears to be acceptable clinically but is not preferable physiologically. One of the functions of the posterior tooth form is to help prevent closing rotations of the mandible in eccentric excursions. This will only be necessary with an inadequate anterior guidance.

Further information can be obtained when the anterior guide angles are examined separately. The incisal guide angle is the

guidance for protrusive excursions and the cuspid guide angle is the guidance for lateral excursions. Companion guide angles in the posterior determinant can be isolated in the same manner, but this determinant is best considered in its total three-dimensional forms since the motion is so much more complex.

It is apparent that a more efficient arrangement is made when the anterior guidance is positive and the posterior occlusal angles are less than the average of the two determinants. This allows immediate disocclusion in all excursive movements dictated by contact on the anterior teeth. This is anterior protection occlusion. If the cuspid guidance is negative or zero, the posterior mesial and distobuccal cusp ridges can support the insufficient anterior guidance by supplying contact in the lateral excursion. This is group function occlusion. If both anterior guide angles are less than the posterior determinant angles, the posterior occlusal angles can be constructed so that they will not be less than the combined determinant angles. This is bilateral balanced occlusion. It is also possible to have posteriorly balanced contacts when there is a positive anterior guide angle, but this necessitates extremely steep posterior cusps and is inadvisable.

Anterior guidance when thought of in this light is dependent upon the posterior determinant and the anatomical relations of the anterior teeth. If the anterior teeth do not permit contact as in class III, severe class II, and anterior open bite dentitions, there can be no guidance on the anterior teeth, and closing rotations of the mandible in eccentric positions should be prevented by posterior occlusal balance. The anterior guidance can also be thought of as dependent upon the posterior occlusion. If the posterior dentition is intact and will not be altered, and the anterior teeth are to be reconstructed, then the guidance will have to be created according to those fixed factors now present. In this instance, they are the condylar determinants and the posterior occlusion. There is in reality an interdependence between all of these factors. One should not be thought of as dominant over any of the others. Only the posterior determinant is distinguished as a fixed or non-changeable

factor, but only at that given moment. No biological mechanism is static throughout life.

Therefore, the mechanical purpose of posterior occlusal balance in an excursion is to compensate for a negative or missing anterior guide angle. This will prevent a closing rotation of the mandible in the excursion and maintain the position of maximum intercuspation as the most closed position. When the occlusal surfaces of posterior teeth contact in this manner, they assume the role of anterior guidance. This is the mechanical purpose of group function and bilateral balance occlusions.

Practical Considerations

Practical application of the principles in this manual may be made with slight modifications of the three exercises. Prior to shaping the occlusal forms, the determinants must be established and coordinated. The posterior determinant is always fixed. The anterior determinant and the posterior occlusion are occasionally fixed.

When the anterior teeth are to be restored, the anterior guide angles will be dependent upon the unalterable determinants. If the posterior occlusion is to be maintained, the posterior determinant in addition to the now fixed posterior occlusion will determine the anterior determinant angles once the style of occlusion has been selected. If the posterior occlusion requires restoration in addition to the anterior teeth, then there is more flexibility in selecting the style of occlusion and the anterior guide angles. If the anterior guidance is to be maintained, the posterior occlusion must be formed according to the remaining fixed determinants (the posterior and anterior determinants).

When considering the determinants in this light, one can easily understand that there is an interdependence between them rather than a dominance of one over the other. When the anterior guide angles have been established, the anterior guide table is adjusted to preserve the selection. This is subject to modification in the wax-up procedure and finally according to the other physiological dictates of the patient (esthetics, phonetics, and comfort).

Sometimes the first decision as to the style of occlusion will have to be changed. When carving the occlusion, anatomical relations may dictate cusp warping. The basic ideas and principles still prevail. Modifications of these make each situation unique to the particular patient and occlusion.

The incisal and cuspid guide angles in a bilateral balance occlusion will be less than those in an anterior protection occlusion. In a group function occlusion, the incisal guide angle will resemble the incisal guide angle in anterior protection, but the cuspid guide angle will resemble the cuspid guide angle in bilateral balance.
In dentulous restorations, bilateral balance is not a recommended style of occlusion. The incisal guide angle should always be sufficient to disengage posterior protrusive contacts. The shallower the cuspid guide angle, the greater is the approximation of contacts in a lateral excursion. In a group function occlusion, posterior contacts are desired on the ipsilateral side. In order to maintain these relations and avoid contralateral side contacts, side stepping of the maxillary lingual cusps is recommended (see page 23). Because of the greater anterior guide angles in anterior protection occlusions, there is more posterior clearance in the excursions. This greater tolerance is why this style of occlusion is preferred wherever possible. Frequently a given or "starting" anterior guidance is of insufficient angulation to satisfy the style of occlusion. Since the condylar determinants cannot be altered, the solution involves the other factors. The easiest and preferable solution is to increase the anterior guide angles until posterior disocclusion is accomplished. If this is not possible, attempt to reduce posterior cusp height in order to gain disocclusion. If this jeopardizes centric stability, a change in the style of occlusion to group function or finally a combination of all three alterations may have to be included.

Setting the Anterior Guide Table

In order to prevent closing rotations of the mandible when moving from the centric position to an eccentric position, a positive or zero guidance either on the anterior teeth or on the posterior occlusion is preferable. The following suggestions of setting the anterior guide table refer to the incisal guide angle, the cuspid guide angle, or both. If the anterior guidance selected will be positive, duplicate the motion on the anterior guide table and carve the posterior occlusion according to the requirements of the style to be utilized (see table on page 25).

If the anterior guidance selected will be zero, duplicate the guidance on the anterior guide table and carve the posterior occlusion. In this situation, the posterior occlusal cusp angles must not exceed the condylar determinant angle. That would place the surface in a premature contacting relation. The posterior cusp angles must equal the condylar determinant angle for balance or be less for disocclusion.
If the anterior guidance is absent (anterior open bite, severe class II, or class III); set the anterior guide table to equal the condylar determinant angle. Then carve the posterior occlusion to balance. The resulting occlusal form will be balance and the posterior occlusion will assume the role of anterior guidance.

Carving the Occlusion

Malposed teeth will have to have warped occlusal anatomy if the positions cannot be corrected. Centric receiving areas may have to be changed in order to accommodate the existing condition. The ideal situation is never found in clinical practice.
When waxing the occlusion, a convenient method of setting up the occlusal form is to apply the wax on the dies in the form of copings. The occlusal tables and the axial contours are then shaped to full anatomical form. The reference lines are scribed with a sharp instrument and the centric receiving areas are determined by considering the available possibilities of the anterior guidance and the locations of the reference lines. Drops of a different colored wax can be placed wherever the centric receiving areas are best located. Then the cones can be placed and the waxing techniques in Exercises I and II can be followed to completion.
When waxing to a cusp-to-fossa arrangement, try placing wax in the centric receiving area to contact the centric cone prior to establishing the inner aspect. Then form the inner aspects to pick up the tripod contact.
The final wax-up should be refined utilizing the occlusal adjustment procedures in Exercise III prior to casting. This is done with talcum powder as the indicant. A careful wax-up should not require extensive refinement.
The supplemental grooves are best carved after the remount refine-

ment procedure is completed. Carving them in the wax is usually a waste of time since the adjustment procedures frequently obliterate these shallow carvings.

Refinement by Reduction (Occlusal Adjustments)

Occlusal adjustments utilizing the grinding rules is a refinement procedure. If the cusps line up tip to tip (see Fig. A) or where the tip of the mandibular buccal cusps are lingual to the receiving fossae (see Fig. B), do not attempt an occlusal adjustment by grinding.
These conditions cannot be corrected by reduction. The solution would be orthodontic therapy (or resetting of teeth in dentures) and then refinement.
Another condition encountered is when there are many premature contacts on the contralateral side. The solution may not be reached by grinding alone. Consider increasing the cuspid guide angle on the ipsilateral side with a restoration. These are examples of how knowledge of occlusion can be applied to clinical situations.

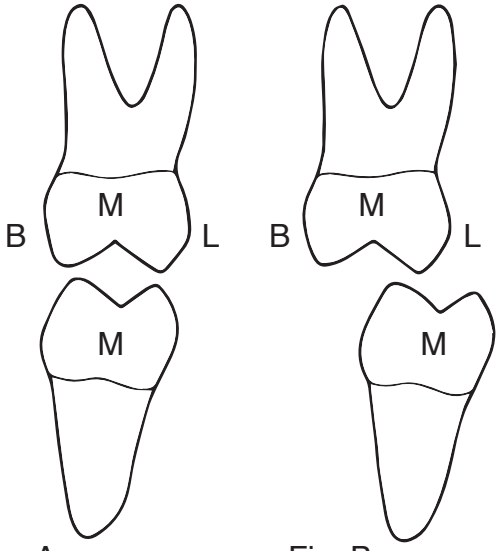
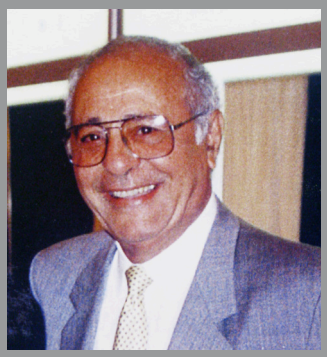


Fig. A Fig. B



Frank Vincent Celenza, AB DDS MSD

- Diplomate - American Board of Prosthodontics
- Founder, Past President, and Fellow - Northeastern Gnathological Society
- Past President - Greater New York Academy of Prosthodontics
- Founder and Fellow - International Gnathological Society
- Founder - Italian Academy of Prosthodontics
- Fellow - American College of Dentists
- Fellow - New York Academy of Dentistry
- Director - American Equilibration Society
- Member - International Society of Neuroscience
- Member - Prosthodontic Group of the International Association for Dental Research
- Clinical Professor Department of Occlusion - Boston University School of Dental Medicine
- Clinical Professor Department of Form and Function - University of Pennsylvania School of Dentistry
- Clinical Professor and Director of Session of Occlusion - New York University, College of Dentistry
- Member - American Academy of Aesthetic Dentistry
- Visiting Lecturer - Columbia University
- Visiting Lecturer - New York University
- Author - *"The Physiological Development of Occlusal Morphology"* Quintessence, 1973
- Co-Editor - *"Occlusion: The State of the Art"* Quintessence, 1978
- Author of books and articles on occlusion and prosthetics
- Teacher in numerous lectures and conferences around the world