Centric Relation: Defined

William H. McHorris, B.S., D.D.S., FACD, FICD
Memphis, Tenn., U.S.A.

INTRODUCTION

Centric relation is a classical dental term, yet by definition it still remains an enigma to the dental profession. This is reflected in the dental literature by the numerous attempts to describe it and define it.

It has been defined as a maxillo-mandibular relationship, a cranio-mandibular relationship and as a mandibular posture that has no particular vertical dimension. In planes of space, it has been described as the most retruded, completely retruded\(^1\), the most superior\(^2\), and as the rearmost, uppermost, midmost posture of the mandible.\(^3\) Some dental educators define it with respect to the condyle-fossa relationship with no mention of the mandible. Unfortunately, some have tried to define this three dimensional posture with two dimensional, radiographic projections of the osseous components.\(^4\) Thus, the controversy continues!

As in any definition, the words of the term defined should reflect their meaning. Centric, an adjective, can mean in, at or near the center. In the case of the mandibular condyles to their fossae, centric could have been realistically chosen as the proper term to use when visualizing the condyle-fossa relationship in dry skull specimens. Unfortunately, the soft tissue of the temporomandibular joints was not given sufficient consideration. Radiographic visualization being devoid of soft tissue imaging, would also lead clinicians to assume the condyles to be at or near the center of the glenoid fossae.

Relation, being the noun in the term centric relation, is defined as the designation of the position of one object as oriented to another. Dental educators have chosen to relate the mandible to the maxilla and the cranium, while relating the mandibular condyles to their fossae.

The objective of this article is to describe and define the three
Fig. 1. Rest position exhibits the muscles of mastication in a relaxed state. It should be considered the most therapeutic posture for the mandible.

Fig. 2. The condyle-disc assembly.

Fig. 3. Translation takes place in the upper compartment.

Fig. 4. Rotation takes place in the lower compartment.

Fig. 5. The anterior and posterior ligamentous attachments, (sagittal view).

Fig. 6. The medial and lateral collateral ligaments, (coronal view).
ANATOMICAL REQUIREMENTS

Centric relation of the mandible cannot be defined solely by anatomical means, except to describe the state and posture of the soft and hard tissues influential in affecting the position. Since the mandible is a suspension of the cranial structures, the physiologic state of these attachment tissues must be considered. While the ligamentous connective tissue attachments exhibit minor actions, the muscular components are responsible for any and all the varied movements of the mandible, excluding gravity. When the muscular attachments are relaxed, the mandible is said to be in the suspended state known as the "rest position" (Fig. 1).

Anatomically, the rest position has the teeth apart and the mandible suspended inferiory to a position dictated by the relaxed length of the muscles attached to it. Thus, the tonicity of the muscular attachments can affect the vertical dimension of rest position.

In healthy, well functioning temporomandibular joints, the two mandibular condyles relate to the articular discs to form the condyle-disc assembly (Fig. 2). It is important to recognize that these two components work as a unit. The mandibular condyle does not articulate with the temporal bone, but with the articular disc to form a separate hinged joint. The condyle-disc assembly articulates with the temporal bone to form a sliding joint. Translation takes place in the upper compartment, and rotation takes place in the lower compartment (Figs. 3, 4). These combined movement potentials are the reason that the TMJ is considered the most complex joint in the body. The condyle and disc assembly are attached to each other anteriorly and posteriorly by the ligamentous components of the articular capsule (Fig. 5). To further assure this "together" relationship are the medial and lateral collateral ligaments of the articular discs which are attached respectively to the medial and lateral poles of the condyles (Fig. 6).

The condyles fit against the disc during function. This would include chewing, swallowing, and speaking. The anatomy of the disc suggests that the anterior, superior articular surface of the condyle be seated against the avascular, aneural center or middle zone of the disc (Fig. 7).

The peripheral portions of the disc around this middle zone are much thicker and anatomically resist the condyles' displacement...
from the articular zone. This periphery is also endowed with blood vessels and nerve endings. The posterior portion of the disc is the largest or thickest of the peripheral borders. The medial portion is also very thick, with the lateral and anterior periphery being much thinner. This anatomical configuration results in a concave socket for the condyle, which promotes the ability of the articular disc to stay with the condyle during all its varied movements.

This anatomical, accommodating configuration that the articular disc provides for the condyle is one of developmental conformity. Observations of the articular disc in newborns and infants describe the disc as a more symmetrical component. It is uniform in thickness with the existence of blood vessels and nerve endings throughout the entire structure. That the disc could evolve to a biconcave structure would suggest that there is strong or constant apposition between the condyle and the disc to the posterior slope of the articular eminence. It is understandable that pressure atrophy of the nerves and blood vessels could result from such apposition, thereby leaving the articular zone of the disc devoid of nerves and vessels. These developmental, accommodating changes in the disc are a classical example of "form conforming to function".

At the rest position of the mandible there are no muscles contracting to assure strong contacts between the parts. Therefore, by the law of "conservation of energy", the rest position of the condyle-disc assembly is considered to be in a non-stress bearing or uncompressed relationship. Rest position would have to be considered the most therapeutic position for the mandible.

Ideally, the condyle-disc assembly is bodily seated against the posterior slope of the articular eminence at the centric relation closed position. This seated or braced relationship is a result of contractions of the closure muscles. It could be said that centric relation is a muscle-induced position. However, the condyles
ability to attain this seated posture is dependent upon three important factors (Fig. 8). First, the inferior heads of both lateral pterygoid muscles, which are attached to the condyles, must be bilaterally relaxed. These muscles relax on closure, but if one or both of these muscles is in a hypertonic, hypercontracted, shortened state, the condyle to which they are attached will be forward and inferior to the desired centric relation position (Fig. 9). This shortened, hypertonic state of the inferior heads of the lateral pterygoid can be a result of “bruxism”, or since muscles have great memory, from a programmed posture dictated by the teeth. Regardless, the centric relation posture desired cannot be obtained unless there is bilateral relaxation of the inferior heads of the lateral pterygoid musculature.

Secondly, there must not be an excessive amount of synovial fluid in the upper or lower compartments of the TMJ (Fig. 10). An increased amount of synovial fluid would obviously alter the normal hydrostatics of this joint and could prevent the desired apposition of the parts necessary to obtain the seated centric relation position. An increased amount of synovial fluid in these compartments is not an uncommon finding in patients who chronically “brux” their teeth and who suffer from TMJ disorders.
Fig. 11. Maximum intercuspation of most dentitions results in an inferior and anterior position of the condyles.

Fig. 12. At centric relation occlusion the condyle-disc assembly are considered to be in a seated compressed position.

Fig. 13. Rest position exhibits the condyle-disc assembly very near or in the same position as centric relation but is considered an uncompressed posture.

Third, and by far the most common deterrent, are the fittings of the occluding parts of the teeth. If the occlusal surfaces of the teeth, at maximum intercuspation, prevent the condyles from seating properly against the disc, the condyles must accommodate to an eccentric posture. This tooth-dictated, eccentric posture the condyles are forced to assume, is usually inferior and anterior to the desired seated centric relation position (Fig. 11).

It should be mentioned that the centric relation position is not commonly coincident with the maximum intercuspation of the dentition. If, however, the closed maximum intercuspation position of the teeth is coincident with the centric relation position, the mandible is said to be in centric relation occlusion. Centric relation occlusion has long been an objective of the restorative dentist and is considered by many to be the most therapeutic treatment position obtainable.

Closure of the mandible requires muscular contractions of the elevator muscles whereby the condyle-disc assembly assumes a
more compressed relationship against the posterior slope of the articul ar eminence than what is evident at rest position. The difference in condyle posture would have to be interpreted by determining the compressibility of the articular discs. This would obviously vary from patient to patient. Whether or not this is measurable does not seem important except for academic reasons. The clinical significance of the compressibility of the articular disc is limited. Suffice it to say that the occlusal prescription provided the patient should be with respect to the closed position of the teeth and this seated compressed posture (Fig. 12). The uncompressed, relaxed posture of rest position need only to be obtainable, for as stated earlier it is the most therapeutic position of all (Fig. 13).

Once it is determined that occlusal therapy is indicated, the correct treatment position for the mandible must be established. Since many restorative dentists and prosthodontists feel that the centric relation position is the most comfortable, repeatable and stable posture for the mandible, their goal is to provide an occlusion that is in harmony with this position.

Much of the controversy about centric relation stems from whether or not the operator can obtain this position in one appointment, and reproduce the same position at any subsequent appointment.

Since the maximum intercuspation position of the mandible is not commonly coincident with the centric relation position, the validity of centric relation is often questioned.

Other controversies about this posture evolve from attempts to eliminate the proprioceptive influences from the teeth by obtaining centric relation registrations. This can only be done by securing these registrations at a more opened vertical dimension than is exhibited at the most closed, tooth dictated position of maximum intercuspation. To assure accuracy of this opened, vertical registration, consideration must be given to the opening and closing axis of the mandible. If correctly related, the fittings of the teeth can then be evaluated with respect to centric relation closures. Any simple, hinge-type openings of the mandible occur about its transverse axis. It is extremely important to note that his axis is constant to the condyles and will accompany the condyles in all their varied movements. Historically, dentistry has attempted to locate this transverse axis and convey its information to articulators by means of a face bow. This procedure orients the maxillary cast, in space, to the transverse axis of the mandible. The mandibular casts can then be properly mounted to the maxillary casts by way of centric relation registrations. These are
Three techniques for taking centric relation registrations

- Chin Point Guidance
- Bimanual Manipulation
- Anterior Deprogramming Devices

usually recorded in wax, paste, or other similar materials. This would be well and good were it not for the fact that after the occlusal prescription has been delivered the condyles assume a more seated position. This is a common problem for the restorative dentist, and his skeptical dental audience is quick to point out that the transverse axis is now in a different position than where it was previously recorded. Even more frustrating to the operator is the existence of deflective contacts on the newly prescribed occlusal surfaces.

The lesson learned from this embarrassing sequence of events is the need to obtain a seated centric relation position of the mandible through occlusal therapy prior to any attempts to locate the transverse axis of the condyles. Any use of kinematic face bows, with styluses, prior to obtaining this seated centric relation position is an exercise in futility, and one guaranteed to produce error.

To reiterate, the most common deterrent to the mandibles, ability to assume a centric relation position is the fittings of the teeth. It is only through proper occlusal therapy that the inferior heads of the lateral pterygoid muscles can be deprogrammed and bilaterally relaxed. It is only through time, following this occlusal therapy, that the excessive amount of synovial fluid in the temporamandibular joint compartments can be eliminated and the normal hydrostatics of the joints reestablished.

Considering all these deterrents, it becomes apparent that centric relation of the mandible cannot be a repeatable stable posture until occlusal therapy has been provided over a sufficient period of time.

There are three fundamental approaches or techniques now prevalent in dentistry to position the mandible in centric relation (Fig. 14).

They are commonly called 1) Chin point guidance, 2) Bimanual manipulation, and 3) Anterior deprogramming devices (Leaf gauge, Lucia jig).
In evaluating these techniques, one should be consciously aware of the anatomical and physiological requirements of centric relation of the mandible.

In “chin point guidance” for example the operator may be able to retrace the mandible adequately, but it requires excellent patient cooperation. The superior seated posture of the condyle-disc assembly is possible to obtain as the closure muscles contract to indent the interocclusal material. This action by the elevator muscles would position the condyles to a more superior and slightly anterior posture than the completely retruded position initially obtained with chin-point guidance. The disadvantages of this technique are operator error in manipulating the mandible, a possible lack of patient ability to relax their musculature, and the presence of a posterior force to the condyles as the closure muscles attempt to position it in a more superior, seated position.

The “bimanual manipulation technique”, as proposed by Dawson positions the mandible posteriorly while simultaneously directs a force superiorly and anteriorly on the condyles. This technique will obtain the desired centric relation position, provided the operator is experienced in this manipulation and patient cooperation is good.

The anterior deprogramming devices, such as the “leaf gauge”, eliminate posterior tooth contacts which eliminates the proprioceptive influence from the teeth. Electromyographic studies have been performed utilizing the “leaf gauge”. They reveal several important points worth mentioning. The only muscles contracting while a patient is biting on the leaf gauge or any similar anterior device are the superior head of the lateral pterygoid muscles and the temporalis muscles (Fig. 15). These studies also revealed that
the remaining elevator muscles (masseter and medial pterygoid) would not contract until a posterior tooth contacted. Other studies have revealed this is probably because of the lack of stimulation of the pressoreceptors of the periodontium of the posterior teeth. In light of these findings it becomes obvious that food, wax or some other material of sufficient integrity would stimulate these pressoreceptors enough to result in contraction of the masseters and medial pterygoids. In evaluating the muscular activity with the leaf gauge in place, contraction of the superior head of the lateral pterygoid muscle attached to the disc, would place the disc in a braced position against the posterior slope of the articular eminence. Contraction of the temporalis muscle, long considered a positioning muscle, would place the condyles superiorly and in close approximation to their articular discs. The condyle-disc assembly now stands in readiness to be seated against the eminence through the efforts of the masseter and medial pterygoid muscles. When the interocclusal material is placed between the teeth and starts to harden, the masseters and medial pterygoids contract to obtain the final seated posture of centric relation (Fig. 16).

Many believe that most of the ills associated with TMJ disorders are coming from the condyle being posteriorly displaced. Some feel that it is placed posteriorly in therapeutic attempts and therefore evolves as iatrogenic results. Unfortunately, most of these observations are derived from two dimensional, distorted radiographic visualizations of the TMJ without other diagnostic confirmations. None of these studies have utilized three dimensional mounted casts to prove their theories of condyle position. If this theory is evaluated anatomically and physiologically, there are several reasons this posterior condylar position would be unlikely.

First, the fibers of the temporomandibular ligament are oriented so that posterior movements of the condyles are limited. Posterior
forces to the mandible therefore tend to pivot the condyles in a superioanterior direction because of the restrictions exerted by this ligament. The capsular ligaments are comprised of dense connective tissues which would also resist posterior displacement in healthy joints. However, microscopic studies of ligaments reveal, anatomically, that a crimped configuration exists, resulting in a wave of fibers. This normal architecture allows the ligament the potential to give or stretch 20 to 30 percent of its actual length. This imparts a pseudoelasticity to the ligaments and permits an elongation of the ligament without actually stretching the collagen fibers. This biomechanical action by the connective tissues should be understood when dealing with TMJ disorders where often times the ligaments are stretched to 70 to 80 percent of their elastic potential. In healthy joints, if the load or stress responsible for this elongation is removed, the tissue will return to its original length without permanent elongation. If the load or stress continues however, the ligaments undergo permanent deformation and can eventually break or tear.

In any synovial joint there exists what is called a “close-packed” position. This is a position where the joint is maximally congruent and cannot accomplish any further movement in that direction, and the ligaments surrounding the joints are tightened. Most of the fractures and maximal derangements of the joints occur in this position. The TMJ has two closed-packed positions. One is the most retruded position of the condyle which could put pressure on the retro-articular tissues and can result in pain. The mechano-receptors of the TMJ are activated in this position and every physiologic protection potential is initiated to protect the retro-articular structures. The second close-packed position of the TMJ is the most anterior position and occurs at wide opening. This places the condyle-disc assembly in hard contact with the articular eminence near its apex. Any movement beyond the apex would result in dislocation. These observations confirm that the condyle must be allowed to function in between these two extremes or in a: “loose-packed” position.

The second reason posterior condylar displacement is unlikely is because of the attachments of the inferior heads of the lateral pterygoid muscles. These muscles insert into the condylar neck. As they contract towards their origin, they pull the condyle-disc assembly down the eminence during functional excursions. On closure, these muscles relax, which allows the condyles to assume their posterior, retruded position. All muscles, even at rest, exhibit a certain degree of elasticity or tone. To place the condyles too far posteriorly against he retroarticular tissues could only occur if these muscles were stretched or torn beyond their physiologic relaxed limits, which, although conceivable, is not probable. Any excess posterior force to the mandible would result in an inferior posture of the condyles. If an excessive blow to the mandible
should occur, the condylar necks of the mandible will fracture before the lateral pterygoids give way. They too, like the ligaments, exhibit the necessary receptors to physiologically prevent the condyles from being placed too far posteriorly.

Some clinicians feel that utilizing the leaf gauge principle can result in a posterior and inferior condylar displacement. For the same reasons just discussed, this is obviously impossible, since the actions of the temporalis muscles while biting on the leaf gauge would position the condyles superiorly. When the masseter and medial pterygoid contract during the centric relation registration any posterior and inferior possibility is obviously eliminated. The patient’s muscles are placing the patient’s condyles where they belong free of tooth interference and without the potential influence of operator error.

A more realistic criticism of the leaf gauge principle should be directed toward the possibility that a flexure of the mandible can occur if excessive biting forces are used. This would account for the mechanical condyles of articulators to be in a more posterior and inferior position in studies devised to check for the accuracy of centric relation mounts. (i.e...Vericheck). Most advocates of the anterior deprogramming devices caution against using excessive biting forces.

Throughout this entire discussion of centric relation the articular disc has been properly positioned over the condyle. The question arises as to whether it is possible to have a centric relation if the disc is partially displaced or completely dislocated from this position. “Bruxism” results in isometric muscle contractions. The contractions can be intermittent or for extended periods of time. The closure muscles are the most active muscles during episodes of bruxing. They are the muscles responsible for holding teeth together forcefully and excessively. The superior head of the lateral pterygoid muscle is also active during closure, but being primarily attached to the disc, it has no active role in closing the mandible.

Fatigue, myospasm or hypertonicity of any muscle results in a shorter muscle in length or one in a partially contracted state. Myospasm or hypertonicity of the superior head of the lateral pterygoid muscle would place a forward and medial pull upon the disc or toward the muscles’ origin and its osseous attachment. If a myospasm of this muscle became chronic, the elastic retrodiscal attachments to the disc that resist this pull, could eventually be stretched to the point of allowing further displacement of the disc toward the muscles’ constant pull. Conversely, relaxation of this muscle would allow the elastic retrodiscal attachments of the disc to reposition it to its proper position. This elastic attachment is the only structure capable of applying traction on the disc in a
A muscle spasm is an involuntary muscle contraction and may not be painful in such a state. When made to contract, it becomes painful and is often referred to as a "cramp". Muscles in spasms are also rigid and usually result in limitation of movement and dysfunction.

A skeletal muscle with associated pain in such a state of contracture, is given immediate attention to gain relief. This is attributed to the excitation of the muscles and tendons mechanoreceptors. To date, there have been no sufficient studies to confirm the presence of stretch receptors in the tendinous attachments of the lateral pterygoid musculature. The contractile state of the superior head of the lateral pterygoid muscle can be tested, however, by utilizing the "leaf gauge principle". This sustained contracture can reproduce the "most painful episodes" of a patient suffering from TMJ dysfunction, and is therefore a worthwhile aid in differential diagnosis. At this particular time it is this writer's opinion that most TMJ muscle pain associated with MPD Syndrome is due to myospasm of this muscle. Utilizing physiologic principles, a muscle in a partially contracted state or myospasm cannot relax until it completes its contraction. The "all or none" law applies to muscle physiology as well as neurophysiology.

The superior head of the lateral pterygoid muscle can be made to complete its contraction utilizing the "leaf gauge principle". Once contracted, the pain and discomfort will stop. Having fully contracted, it can now relax as the patient opens. When relaxed, the elastic retrodiscal attachments of the disc can exercise their role in reposturing the disc posteriorly over the condyle.

Nocturnal bruxism can result in myospasm or hypertonicity of the superior head of the lateral pterygoid muscle on a nightly basis. This would, in essence, place the disc in a more anterior and medial posture over the condyle, resulting in a greater incidence of noises to occur as the condyle-disc relationship is altered. If, however, this same muscle is forced to complete full contracture on a daily basis utilizing the leaf gauge principle, the condyle-disc relationship can be restored and can function together free of noises.

Centric relation has the condyles articulating with the thinner articulating zone of the disc. Any articulation of the condyles with any portion of the thicker peripheral zones of the disc would result in a more inferior posture of that condyle. This position would not satisfy the centric relation requirements. If the articular disc is anteriorly dislocated, the condyles would then be articularizing with the retroarticular tissue, commonly referred to as the posterior direction.
bilaminar zone (Fig. 17). This would obviously be painful, as this tissue is richly endowed with vessels and nerves. These tissues would immediately be subject to pressure atrophy which would allow the condyle to gradually superiorize. It is not uncommon to find a perforation of the bilaminar zone in such cases. Recent microscopic investigations and histologic evaluation of surgically excised bilaminar zones reveal interesting findings. Some indications that this tissue is undergoing favorable adaptive changes include the presence of thickened arterial walls, suggesting decreased blood flow, and the tendency for decreased amounts of elastin to be associated with more dense collagen. Other studies show an increased amount of fibroblastic activity in the tissues adjacent to where the condyle was articulating. It is as if the body is trying to form a new disc or a toughened zone of tissue.
with which the condyle can articulate. This type of research helps support conservative occlusal therapy and stresses the importance of time and nature's healing qualities before hasty, more radical therapeutics are attempted. If the pain abates and the patient is comfortable, a centric relation registration could then be obtained, utilizing the conventional techniques discussed, but the anteriorly dislocated disc would obstruct the patient's range of motion and function. The permanence of this centric relation would obviously be questionable as further atrophy of the bilaminar zone could occur. Only time will tell.

The seemingly popular technique of moving the mandible forward to capture the anterior displaced or dislocated disc is not without its problems and resultant complications. This forward posture would require inexhaustable cooperation from all the musculature attached to the mandible and is in conflict with the usual retruded positions exhibited in swallowing and final chewing closures (Fig. 18).

If the patient's mandible is kept in this forward position for extended periods of time irreversible consequences may develop. Reports are surfacing which show that intrusion of the posterior teeth is a rather common finding. Orthodontics, orthognathic surgery and extensive restorative procedures are often required to correct these resultant malocclusions and posterior open bites. Before the use of such anterior positioning appliances, the patient should be informed of these potential irreversible consequences. In reference to centric relation, the anterior positioning appliance attempts to correct the condyle-disc relationship, but defies the normal muscular orientation of the condyle-disc assembly properly to their respective fossae. All conservative, rational attempts should be made to return the condyles and their discs to the centric relation position (Fig. 19).

Other factors that could affect the permanence of centric relation would be the possible changes in the osseous components. Most studies support earlier findings that remodeling of the condyles increased significantly as teeth were lost. These studies help confirm that the teeth should support and protect the centric relation position of the condyles.

The final worthwhile objective of any type of occlusal therapy or restorative procedure, is to obtain stability of the treated result. The most obvious avenue for gaining and maintaining this stability must be accomplished by working at the tooth level. The more stable the occlusion, the more stable the centric relation position of the mandible. The articulations of the teeth should allow the condyles to assume their seated position against their articular discs. The inclines of teeth should never have deflective contacts that would distalize, inferiorize, or anteriorize the condyles seated,
closed position. Once this position is obtained, it becomes the responsibility of the posterior teeth to support and protect it (Fig. 20).

CENTRIC RELATION DEFINED

Centric relation is the physiologic relationship of the mandible to the maxilla and the cranial base, when both condyles are properly related to their articular discs whereby the condyle-disc assemblies are stabilized against the posterior slopes of the articular eminences of the glenoid fossae. This relation may occur at varying vertical dimensions of rotation of the mandible preceding any translation of the condyles.

Notes:
1. Centric relation exhibits the condyle-disc assembly in a braced position that can be recorded.
2. Centric relation is considered a border position that may be related to the mandibular transverse axis.
3. Centric relation is a position that is not commonly coincident with the maximum intercusaption of the dentition.
4. Centric relation, when coincident with the maximum intercuspations of the teeth can be considered in the mandibular posture known as centric relation occlusion.

In summary, the anatomical, physiological and therapeutic requirements of centric relation have been evaluated and discussed. One must always be aware of the limiting factors which prevent the mandible’s ability to obtain the centric relation position. The bilateral relaxation of the inferior heads of the lateral pterygoid muscles, the reduction in any excess edema and the deflective occlusions are those factors that must be dealt with systematically and patiently. The technique utilized to obtain this position is not important provided the desired results are obtained. The materials
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nor instruments utilized to record this position are not important provided the desired results are obtained. What is important is whether or not this centric relation position is clinically dependable, and exhibits credibility as a treatment position.

What is also important is that when the mandible is affected by trauma, disease or dysfunction, the centric relation position is a posture for the mandible that is conducive to healing, and one that is in harmony with the biomechanics of the gnathic system.

REFERENCES


Dr. W. H. McHorris
3100 Walnut Grove Rd., Suite 302
Memphis, Tennessee, 38111
U.S.A.