6. STROHAVER R.A.
   - A comparison of articulating mountings made with centric relation and myocentric position records
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Purpose of study:

Method:

Results:

Discussion:

Conclusions:

Comments:
Fixed partial prosthodontics

A comparison of articulator mountings made with centric relation and myocentric position records

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When an entire occlusion must be reconstructed on an articulator without benefit of the relationship of the jaws provided by the maximum intercuspal position of natural teeth (occlusal position or centric occlusion), some other repeatable reference relationship is necessary. Centric relation is considered to be the only other repeatable reference relationship with which to coordinate the occlusion.1,2 Although it has been stated that no other phase of dentistry is so important as a clear understanding of centric relation,3 this relationship continues to mean different things to different people. Definitions of centric relation are so numerous and varied that this term is practically useless unless it is accompanied by the user’s definition.

Even if there were general agreement about the definition of centric relation, dentists would still be faced with the problem of recording this relationship and transferring it to an articulator. This critical transfer, which can be one of the weakest links in a painstaking technique, is frequently accomplished with some type of interocclusal record. Attaining an accurate centric relation record has been called the most important single step in the construction of any complete prostheses.4' 3 Despite the importance attributed to this procedure, there is a wide divergence of opinion concerning the methods and materials to be used for making centric relation records. The unfortunate cloud of controversy surrounding centric relation was apparent to Stallard and Stuart' who wrote, “I suppose we fear centric relation as the superstitious fear a ghost because we do not understand it.”

Recently a new maxillomandibular relationship with which to coordinate the occlusion was introduced. The jaw relation is called “myocentric position” and is defined as the position to which the muscles carry the mandible if no deflective factors exist on teeth or occlusion rims.

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Myocentric position is recorded automatically, without manipulation of the mandible by the dentist or voluntary closure by the patient, by the use of an electronic device called the Jankelson Myo-Monitor.* Advertising claims state that the Jankelson Myo-Monitor delivers “unequaled precision in the registration of occlusion,” and that these occlusal registrations are “consistently reproducible.” In complete denture construction, the device is said to be useful in molding impressions, border molding, establishing jaw relationships, making postinsertion adjustments, and relining. The Myo-Monitor is also suggested for use (1) in full mouth reconstruction, occlusal adjustment, and orthodontics, (2) in the treatment of temporomandibular joint dysfunction syndrome, and (3) in reducing postoperative trismus and swelling.

OBJECTIVES

Nebulous claims of clinical success have become insufficient criteria for the selection of techniques for making jaw relation records. The objectives of this study were: (1) to determine whether consistent articulator mountings of a mandibular cast could be made using centric relation records made by several dentists (four different methods for making centric relation records were tested); (2) to determine whether consistent articulator mountings of a mandibular cast could be made with myocentric position records produced by several dentists using the Jankelson Myo-Monitor; (3) to evaluate the constancy with which articulator mountings of a mandibular cast could be made when several dentists hand-articulated the casts in maximum intercuspation (occlusal position or centric occlusion) and (4) to compare and evaluate the relative repeatability as well as the jaw relationships produced on the articulator by each of these six methods.

MATERIALS AND METHODS

A 31-year-old male graduate student served as the subject. The subject had a full complement of natural teeth with the exception of third molars, was free of caries, had good periodontal health, and had no signs of functional disturbances of the masticatory system. The subject’s mandibular hinge axis had been previously located and tattooed on the skin.

At the beginning of the study, the hinge axis was again located by Dr. Charles E. Stuart, using the Stuart** head frame and reference plate assembly kit. The original tattoos had faded, but they were verified and again tattooed. An anterior third point of reference was also selected and tattooed on the side of the nose. At the conclusion of the study, the hinge axis was located a third time using cast aluminum clutches and the Stuart hinge-axis locator. The locations of the original tattoos were again verified. In addition, pantographic tracings were made on each of these occasions, and it was demonstrated that the dentist could not forcefully retrude the subject’s mandible beyond the point from which lateral movements could be made.

Nine extension rods were cut 2 inches in length on a lathe from 3/16 inch diameter, stainless steel stock.

**Dr Charles E. Stuart, Ventura, Calif.
Fig. 1. Diagram of casts with extension rods and measurement triangles. By an analysis of the geometry of the extension-rod measuring device, it was shown that the device is sensitive to movements smaller than it is possible to measure (0.0002 inch) by the method used.

One end of each rod was smoothed, scribed, and center punched. The center punch points provided definite measurement points in the ends of the rods. An accurate pair of the subject's die stone cast was selected for use throughout the study. Holes, approximately 3/4 inch deep, were drilled in the bases of the casts to accommodate the extension rods. The rods were positioned (Fig. 1) so that, when the casts were mounted on the articulator, their exposed ends formed triangles in the frontal plane and the right and left sagittal planes. The sagittal planes were at approximately the same distance from the midsagittal plane as the kinematic centers in the ends of the axis shaft of the articulator.

Five triangles were produced by this design which permitted measurements to be made both between the relationships of the two casts and the relationships of the mandibular cast to the axis of the articulator (Fig. 2). Extension rods were employed in order to magnify small changes which occurred between the casts in the various mountings so such changes could be measured by a readily available
Magnification of movement to simplify measuring and to facilitate accuracy is common in industry and was previously employed in dentistry.7,8

A kinematic face-bow transfer from the subject was made using a Stuart face-bow assembly. The specially prepared maxillary cast was mounted with artificial stone on a Hanau OSU Model 130-28* articulator. This instrument was selected, because it provided a secure, stable opening axis, and it would accept a kinematic face-bow. All other adjustable articulator parts were securely fixed. The relationship of the maxillary cast to the axis of the instrument, as well as to the apices of the five measurement triangles, remained constant throughout the study.

Four methods for making centric relation records were selected for comparison.

*Hanau Engineering Company, Inc., Buffalo, N.Y.
Each method involves a different recording material and different technique for recording centric relation. None of the four methods is recommended for both dentulous and edentulous patients alike or as a panacea for solving all clinical problems in recording centric relation.

*Method Z* is a modification of the Jones bite-frame technique described by Huffman, Regenos, and Taylor. This method involves the use of an anterior jig, similar to that described by Lucia. The recording material, a zinc oxide and eugenol paste, is carried to the mouth on thin fiberglass mesh luted to a wire frame with soft wax. *Method W* is described by Wirth and Aplin, and the recording material is Aluwax which is reinforced with Ash’s metal. The completed record has a chilled Aluwax anterior stop to prevent tooth contact. The record is verified when repeated hinge closures produce identical indentations in the wax.

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† Formulator Occlusal Mesh, Formulator Inc., Blue Island, Ill.
‡ Aluwax, cloth form, Aluwax Products Company, Grand Rapids, Mich. §Claudius Ash Inc., Niagara Falls, N. Y.
§ Claudius Ash Inc., Niagara Falls, N. Y.
Table 1. The six methods tested for recording jaw relationships

<table>
<thead>
<tr>
<th>Method</th>
<th>Jaw relationship</th>
<th>Method of jaw positioning</th>
<th>Recording materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>Centric relation</td>
<td>Forceful guidance by dentist</td>
<td>ZnOE paste, bite frame, Lucia jig</td>
</tr>
<tr>
<td>W</td>
<td>Centric relation</td>
<td>Forceful guidance by dentist</td>
<td>Wax reinforced with Ash's metal</td>
</tr>
<tr>
<td>P</td>
<td>Centric relation</td>
<td>Voluntary retrusion by patient</td>
<td>Impression plaster</td>
</tr>
<tr>
<td>A</td>
<td>Centric relation</td>
<td>Forceful guidance by dentist</td>
<td>Acrylic resin, Stuart jig</td>
</tr>
<tr>
<td>M</td>
<td>Myocentric position</td>
<td>Automatic stimulation by Myo-Monitor</td>
<td>Imprint plastic</td>
</tr>
<tr>
<td>O</td>
<td>Occlusal position</td>
<td>Casts hand articulated by dentist</td>
<td>(Maximum intercuspation of teeth)</td>
</tr>
</tbody>
</table>

between the most posterior occluding teeth on each side of the arch. Method P is a technique described by Boucher for recording centric relation for edentulous patients. The recording material is impression plaster. Since any forceful guidance or manipulation of the mandible by the dentist could result in displacement of the recording bases on the edentulous tissues, the patient is asked to pull his lower jaw back as far as he can and close into the recording material.

Method A is a demonstration technique formerly used by Stuart.* The recording material is autopolymerizing acrylic resin.† The end of a tongue blade or Popsicle stick is inserted between the incisors as the subject closes into the recording material and the dentist pries slightly downward and backward to encourage posterior closing. Although Stuart now considers other materials to be more accurate for recording centric relation, it was of interest to test an acrylic resin method.

In Method M, myocentric position records were made using the Jankelson Myo-Monitor. The recording material is Sapphire Myo-Print imprint plastic.‡ These records were made following the manufacturer’s directions both in the use of the device and the handling of the material. In Method O, the cams were hand articulated in maximum intercuspation. Method O allowed a comparison to be made between a known, functional jaw relationship (occlusal position or centric occlusion) and the relationships produced with centric relation and myocentric position recording methods (Table 1).

Three dentists each made a series of 3 interocclusal records by each of the methods described. Additional series of 3 records each were made by (1) Dr. R. W. Huffman (Method Z), (2) Dr. C. O. Boucher (Method P), and (3) Dr. C. E. Stuart (Method A). As each jaw relation record was completed, a separate articulator mounting of the specially prepared mandibular cast was made. Magnetic splint mounting plates§ were used to minimize damage to the base of the cast during these remounting procedures.

* Stuart, C. E.: Personal communication, Jan. 21, 1971.
† Neopar tooth acrylic, Miner Dental Products Company, Emeryville, Calif.
‡ Myo-Tronics, San Francisco, Calif.
Comparison of articulator mountings 385

remounting procedures. Each articulator mounting was made by the author using impression plaster and a standardized technique.

MEASUREMENTS AND CALCULATIONS

The distances between the center punch points in the ends of the extension rods were measured with the pointed ends of a vernier caliper.* These distances represented the sides of 5 triangles which were measured to the nearest 0.001 inch. Each triangle was numbered as shown in Fig. 1, and the sides and angles were labeled as shown in Fig. 2. Sides A and B of all five triangles were measured 4 times for each articulator mounting, and these measurements were averaged. Since side C in each triangle was constant, it was measured 4 times both at the beginning and at the conclusion of the study. All measurements were made with the records in place between the casts, and the die stone teeth were not allowed to contact except in Method 0 when measurements were made with the teeth in maximum intercuspal position. The 3 angles of each of the 5 triangles were calculated for each articulator mounting by an IBM 1620 computer.

*The L. B. Starrett Company, Athol, Mass.

Fig. 4. Relative mean variability in the mandibular cast—articulator axis relationships produced by each of the six methods.
ANALYSIS OF DATA AND RESULTS

Data from 63 articulator mountings were collected in groups corresponding to the 6 methods by which the mountings were made. Within these groups, the lengths of sides $A$ and $B$ and the angles $\alpha$ and $\beta$ were compiled for each of the 5 measurement triangles, and the arithmetic means, the standard deviations, and the coefficients of variation were calculated. The coefficient of variation, expressed as a percentage, was used to compare the variability of the 6 methods for mounting the lower cast on the articulator.

The coefficients of variation for both sides $A$ and $B$ in triangles I, II, and III were then compiled within each of the 6 methods and arithmetically averaged. This provides a mean variability for the maxillomandibular relationships produced by each of the 6 methods (Fig. 3). The coefficients of variation for both sides $A$ and $B$ in triangles IV and V were also compiled within each method and averaged. This provides a mean variability for the mandibular cast-articulator axis relationships produced by each method (Fig. 4). The coefficients of variation for angle $\alpha$ in all 5 triangles were compiled within each of the 6 methods and arithmetically averaged. These results provide a composite mean variability for each method, which is an indication of the relative repeatability of each of the 6 methods for recording jaw relationships (Fig. 5).
It can be noted (Fig. 1) that as the mandibular cast moves posterosuperiorly, the sides A and B in triangles IV and V decrease in length. Thus, the method which recorded the rearmost, uppermost relationships of the mandible with respect to the maxillae would also produce the shortest mean lengths of the sides of these triangles. Graphs were made by plotting the mean lengths of side A against those of side B in triangle IV for each method tested (Fig. 6) and the mean lengths of side A against those of side B in triangle V for each method tested (Fig. 7). The graphs illustrate the relative mean relationships of the mandibular cast to the articulator axis produced by each of the 6 recording methods in the right and left sagittal planes.
CONCLUSIONS

(1) The zinc oxide and eugenol method (Method Z) utilizing a Lucia jig produced the least variable group of articulator mountings made with interocclusal records.

(2) Method Z also produced the most posterosuperior (retruded) relationships of the mandibular cast to the axis of the articulator.

(3) The least variable of all methods for mounting the mandibular cast was Method 0 in which the casts were hand articulated in maximum intercuspation (occlusal position or centric occlusion).

(4) Myocentric position records made with the Jankelson Myo-Monitor (Method M) produced the most variable group of articulator mountings of the 6 methods tested.

(5) Method M also produced the most anteroinferior (protruded) relationships of the mandibular cast to the axis of the articulator.
DISCUSSION

Centric relation is a treatment position that continues to be important in the absence of an acceptable occlusal position because of its relative repeatability and in spite of its variability. It is evident that different definitions of centric relation and different methods for recording centric relation produce measurably different jaw relationships.

In this study, the most retruded articulator mountings of the mandibular cast were also the most consistent mountings made with interocclusal records. It is interesting to note that these interocclusal records were made by forceful retrusion of the subject’s mandible by the dentist. The subject’s hinge axis, which was used to orient the maxillary cast to the articulator, was also located by forceful retrusion of the mandible. Although Ramfjord and Ash\textsuperscript{13} state that forceful retrusion of the mandible is an unreliable way of recording centric relation, the results of this study support the views of Sicher and DeBrul\textsuperscript{14}.

These writers state that, “. . . simple hinge swinging of the jaw can occur only when the mandible’ is forcefully retracted.” They continue by saying that, “. . . pure hinge movement in biology has its characteristic variability and is not to be understood as a statement of precise machine tooling.”

It is surprising how relatively few writers define centric relation as the relation-ship of the jaws to an axis. The use of a clinical technique involving an articulator implies or assumes a repeatable, anatomic axial relationship common to both jaws. Brotman\textsuperscript{15} has demonstrated by mathematical means that a precisely measurable error is introduced at the occlusal surfaces of the teeth when the relationship of both casts to the mechanical hinge of the articulator does not coincide with the relationship of both jaws to the anatomic hinge.

Certainly, the biologic variability of the anatomic hinge cannot be overcome and there are many potential sources of error in recording and transferring centric relation to an articulator. Certainly, it is clinically impractical to construct clutches, locate the hinge axis, make multiple interocclusal records, and use a fully adjustable articulator and split-cast mounting procedures for every patient. Of course, more arbitrary techniques, in the hands of careful dentists, produce clinical results which are within the “adaptive range” of most patients. However, the theory concerning centric relation should be the same whether the patient is being treated by a dentist oriented toward complete denture prosthodontics, fixed or removable partial denture prosthodontics, periodontics, or orthodontics.

I wish to express my appreciation to Dr. Dennis W. Foreman, of The Ohio State University, College of Dentistry, for the error analyses and the Fortran II Computer Program used in this study.

References
6. Stallard, H., and Stuart, C. E.: Oral Rehabilitation and Occlusion, Vol. II. An Address Before the 1963 Graduate Class in Orthodontics at Lorna Linda University, University of California, San Francisco Medical Center, p. 27.

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