The maxillary and mandibular casts of 45 healthy and dentulous subjects, with conspicuous wear facets on canines and molars, were mounted on a semiadjustable articulator. The sagittal condylar guidance was determined by two methods: (1) using a protrusion wax interocclusal record and (2) by matching the wear facets of opposing canines and contralateral molars. There was a substantial bilateral symmetry of the right and left sagittal condylar guidance angles using both methods. There were, however, significant differences between the mean angles of the two methods, about 31° (protrusion record) versus about 24° (wear facets). This, in association with rather low coefficients of linear determination, suggested that the two methods of recording the sagittal condylar guidance angle were based on totally different phenomena. Int J Prosthodont 1991;4:469-472.

In dentistry, articulators are used to replicate certain interocclusal positions and some mandibular movements made by the patient. The accuracy with which certain mandibular movements are replicated depends on the sophistication and adjustability of the articulator. Using proper technique, the semiadjustable articulator (Hanau 96H2-O, Teledyne Hanau, Buffalo, NY) is capable of replicating specific points on the path of the condyle during a protrusive movement, when set with an interocclusal positional record.

The condylar elements of the articulator glide in slots and can be inclined to provide a rectilinear simulation of the curvilinear noncontact (teeth) condylar path. The condylar sagittal guidance inclination, which is set with the protrusive interocclusal record, is measured in degrees relative to the third point of reference. This angle is a relative measure—and not an absolute value—related to the angle of the eminence of the temporomandibular joint.

It has been suggested that the condylar inclination can also be set by the matching of wear facets in a laterotrusive movement. This method is advocated either when a protrusion record has not been made or as a verification of the accuracy of the protrusion registration.

The purpose of this study was to compare the articulator settings obtained using a protrusional positional record with those obtained through matching certain wear facets in a laterotrusive position. The null hypothesis of the study was that there is no statistically significant difference between the mean sagittal condylar guidance angles of a semiadjustable articulator when set through a protrusional interocclusal record and the matching of wear facets in a static laterotrusive position. The alternative hypothesis implied, of course, a significant difference between the two means.

Materials and Methods

The participants in the study were 45 dental students (13 women and 32 men, average age 28 years). They were selected using the following criteria: conspicuous wear facets, not precluding canine or anterior guidance, visually present on the canines and contralateral molars; normal mandibular mobility; freedom from pain in the temporomandibular joints and muscles of mastication; and
Table 1  Values for Right and Left Sagittal Condylar Guidance Angle Determined by Protrusion Records and Wear Facets in 45 Subjects

<table>
<thead>
<tr>
<th>Method</th>
<th>Sagittal condylar angle</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protrusion record</td>
<td>( \bar{x} )</td>
<td>31.5°</td>
<td>30.8°</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>10.7°</td>
<td>13.3°</td>
</tr>
<tr>
<td></td>
<td>SE</td>
<td>1.3°</td>
<td>2.0°</td>
</tr>
<tr>
<td></td>
<td>CV</td>
<td>34%</td>
<td>43%</td>
</tr>
<tr>
<td>Wear facets</td>
<td>( \bar{x} )</td>
<td>23.8°</td>
<td>24.1°</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>11.6°</td>
<td>13.3°</td>
</tr>
<tr>
<td></td>
<td>SE</td>
<td>1.7°</td>
<td>2.0°</td>
</tr>
<tr>
<td></td>
<td>CV</td>
<td>49%</td>
<td>55%</td>
</tr>
</tbody>
</table>

\( \bar{x} \), arithmetic mean; SD, standard deviation of \( \bar{x} \); SE, standard error of \( \bar{x} \); CV, coefficient of variation.

Results

Using the protrusive records, the mean sagittal condylar guidance angle was 31.5° (SD 10.7°) on the right side and 30.8° (SD 13.3°) on the left side (Table 1). A mean difference of 0.69° (SD 8.0°) was not significant (\( t = 0.5778; df = 44; 50 < P < .60 \)). The linear association between the right and left angles showed \( r = +0.7964 \) (Table 2) and \( r^2 = 0.6342 \) (df = 43; \( P < .001 \)). Because 63% \( (r^2 = 0.63) \) of the variation of the right angular measurements was significantly \( (P < .001) \) explained by that of the left angular measurements, and vice versa, there was substantial bilateral symmetry.

Using the wear facets, the mean sagittal condylar guidance angle was 23.8° (SD 11.6°) on the right side and 24.1° (SD 13.3°) on the left side (Table 1). A mean difference of 0.09° (SD 11.4°) was not significant (\( t = 0.0520; df = 44; 95 < P < .98 \)). The linear association between the right and left angles showed \( r = +0.5856 \) (Table 2), and \( r^2 = 0.3429 \) (df = 43; \( P < .001 \)). Again, the significant linear association suggested a substantial bilateral symmetry.

The mean values for the right angular measurements, determined through protrusion records (31.5°) and wear facets (23.8°), were significantly different (\( F = 1.1884; P > .50; t = 3.2724; df = 88; .001 < P < .005 \)). The mean values for the left angular measurements, determined through protrusive records (30.8°) and wear facets (24.1°), differed significantly from each other (\( F = 1.0019; P > .50; t = 2.8034; df = 88; .005 < P < .01 \)). Whether determined using protrusive records or wear facets, all sagittal condylar guidance angles showed a wide range of variability—coefficients of variation ranged from 34% to 55% (Table 1). Although significant, the linear association between the right guidance angles, determined by protrusion records and wear facets, was only \( r = +0.4429 \) (Table 2) with \( r^2 = 0.1961 \) (df = 43; \( P < .001 \)).
In other words, only 20% of the variation of the measurements, determined by protrusion records, could be explained by that of the measurements determined through wear facets. Similarly, the linear association between the left angular measurements, determined by protrusion records and wear facets, was only $r = +0.3259$ (Table 2) and $r^2 = 0.1062$ ($df = 43; .02 < P < .05$). Only 11% of the variation of one variable could be explained by that of the other (protrusion records versus wear facets).

### Discussion

Relative to the sagittal condylar guidance angle, also referred to as the eminence angle, a minimum of four different anatomic factors must be considered: the anatomy of the articular tubercle (hard tissue), the anatomy of the articular disk (soft tissue), the functional anatomy of the articular disk (pliable tissue), and the anatomy of the occlusal surfaces of the involved teeth (hard tissue).

Referring to the Frankfurt horizontal, the eminence angle of the bony eminencia changes from the most lateral (outermost) to the most medial (innermost) areas of the articular tubercle. The angle of the most lateral portion is about 45°, that of the adjacent lateral and midglenoid portions is about 52°, and that of the most medial portion is about 49°.2,3

The bony guidance of protrusion is thus approximately 52° and that of laterotrusion approximately 49°. In vivo, however, the condylar guidance of a healthy temporomandibular joint is primarily determined by the soft and pliable tissues of the articular disk.4 In addition, the gross anatomy of the disk shows that it increases slightly in thickness from the lateral to the medial margin.5,6 Also, the eminence angle created by the superior surface of the disk (in contact with the tubercle) is greater than that created by the inferior surface of the disk (in contact with the condyle); the superior angle is about 50° and the inferior angle about 30°.6,9

As determined by the functional anatomy of the articular disk, it appears that the condylar guidance angle of protrusion is about 35° and that of laterotrusion is about 30°.10 The condylar guidance angle created by protrusion is associated with a 3-mm anterior displacement of the disk; that created by laterotrusion is associated with a 6-mm anterior displacement of the disk.10 These observations pertain to passive movements of the disk in elderly autopsy material.

The occlusal anatomy of the teeth may show pronounced variability because of different wear patterns,11,12 and the anterior guidance of the teeth is approximately 10° steeper than the posterior guidance of the temporomandibular articulations.1,3,15 When opposing teeth are not in contact, the eminence angle is determined by the anatomy and physiology of the temporomandibular joints. When opposing teeth are in contact, the condylar guidance is to a great, if not complete, extent determined by the anatomy of the contacting tooth surfaces, and the two determinants (joints/teeth) will usually not result in identical sagittal condylar guidance angles.3

As determined by a protrusion record, this study found substantial bilateral symmetry of the right and left sagittal condylar guidance angle: about 31° on both sides (Tables 1 and 2). From this discussion it must be assumed that the angle was determined primarily by the component parts of the temporomandibular joints. As determined by wear facets of teeth, this study also demonstrated bilateral symmetry of the sagittal condylar guidance angle: about 24° on both sides (Tables 1 and 2). There was, however, a significant difference between a mean angle of about 31° and that of about 24°, and the coefficients of determination shown in Table 2 (0.20, 0.11) suggest that the two methods of recording the sagittal condylar guidance angle are based on totally different, probably incompurable, phenomena. The suggestion is based on the fact that the null hypothesis was not accepted, but the alternative hypothesis was.

While the sagittal condylar guidance angle obtained with the use of a protrusion record may accommodate the angle required for laterotrusion, with worn opposing teeth in contact (Table 1) it should probably be increased by 5° to 10° to accommodate the angle required for protrusion (with opposing teeth in contact).12,14 The rationale for the recommendation are the observations that the articular angle required for clinically relevant protrusion without opposing teeth in contact is about 30°, that required for clinically relevant pro-

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**Table 2 Coefficients of Correlation (r) and Determination ($r^2$) for Linear Covariation Between Right (R) and Left (L) Sagittal Condylar Guidance Angle (a) Determined by Protrusion Records (PR) and Wear Facets (WF) in 45 Subjects**

<table>
<thead>
<tr>
<th>Covariabes</th>
<th>$r$</th>
<th>$r^2$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPPa/LPPa</td>
<td>+0.80</td>
<td>0.63</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>RWFa/LWFa</td>
<td>+0.56</td>
<td>0.34</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>RPPa/RWFa</td>
<td>+0.44</td>
<td>0.20</td>
<td>&lt;.005</td>
</tr>
<tr>
<td>LPPa/LWFa</td>
<td>+0.33</td>
<td>0.11</td>
<td>&lt;.05</td>
</tr>
</tbody>
</table>

$P$, level of statistical significance.
trusion with opposing teeth in contact is about 35°, and that required for clinically relevant laterotrusion with opposing teeth in contact is from about 40° to about 50°.

**Conclusion**

Under the conditions of this study, it was concluded that the sagittal condylar guidance angle of a semiadjustable articulator showed a significant difference between the mean value for the angle obtained with a protrusive interocclusal wax record and that for the angle obtained through matching wear facets in a static laterotrusive position.

**References**
