The Effect of the Central Bearing Plate Form on the Fischer Angle

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INTRODUCTION

The Fischer angle, which has been defined as "the angle between the inclinations of the protrusive sagittal condyle path and the lateral sagittal condyle path," arises from the difference in the mandibular sagittal paths during protrusive and lateral movements, and is said to have an average value of $5^\circ$.\(^1\)

About 1926 Fischer discovered, after geometrically analyzing incisal guidance, in natural dentition, that a difference occurs in the sagittal incisal path inclination between protrusive and lateral movements, and reported that, in order to reproduce this, a trough-like incisal guide plane folded in two places with a $10^\circ$ lateral incisal inclination would be necessary.

Gysi, in his later years, acknowledged that Fischer's theory was correct and in 1949 developed the Gysi-Fischer Articulator which adopted Fischer's two fold incisal guide plane. The term Fischer angle seems to have arisen from the approximate $5^\circ$ difference which occurs at the condyle between the protrusive and lateral sagittal condyle path inclinations when these two are affected by the $10^\circ$ inclination in the lateral incisal path.

Concerning the Fischer angle, Guichet\(^2\) noted that because the condyle during lateral movements travels more medially than during protrusive movements, the balancing condyle path is more interior (medial) than the protrusive condyle path, and in most cases has a steeper inclination. In contrast to the fact that the protrusive condyle path inclination has its primary influence on the molar protrusive inclines, the balancing side condyle path inclination primarily affects the balancing side molar balancing surfaces (the mandibular buccal cusp mesial internal inclines and the maxillary lingual cusp distal internal inclines). For these reasons, the Fischer angle affects the angle formed by the molar protrusive and balancing inclines (the frontal plane developmental angles).

In recent years, several researchers have questioned the existence of the Fischer angle. In particular, Lee was a leader in taking a position against its existence. He maintains that the Fischer angle is a mechanical illusion arising as a result of making measurements outside the facial surface (as is done with a pantograph) and that it
Kamimura

does not exist at the center of the condyle.

In contrast to this, using a newly developed mandibular movement automatic electronic measuring device, Hobo and Mochizuki calculated with a computer the locus of movement at the center of the condyle to a precision of 0.06mm. They reported that when the condyle point was at a distance of 5mm from centric relation a Fischer angle in the region of 0° to 10° was observed in 70% of the subjects with the average value being 6.5°. From this study Hobo suggested that it is the central bearing plate and not the location where the measurement points are placed that affects the existence of the Fischer angle.

The clutch was devised by McCollum during the basic research phase of gnathology for the purpose of fixing a measuring device securely to the dentition. At first the clutch was a tooth contacting type which was equipped with a surgical plastic-like form. However, since this type of clutch takes more than eight hours to attach, it is not considered to be practical and the clutch commonly used today which has a central bearing plate and screw was perfected. McCollum has reported that, using this device, it has become possible to measure the condyle movements only, without the interference of tooth contact.

It is now commonly accepted that the configuration of the central bearing plate should not have any effect on the form of the condyle path. Cohen developed an aluminum clutch which could be fixed magnetically to three types of central bearing plates — convex, concave and flat types. Using these three types of clutches he made pantograph tracings and using one setup (for example the convex plate and its associated tracing) he adjusted the movements on a fully adjustable articulator. Then he interchanged the other two setups of plates and tracings and reported that the path of the pantograph stylus in all cases agreed with the lines on the tracings corresponding to that particular plate. From this Cohen concluded that the shape of the plate had no effect on the condyle path.

Clayton, using an aluminum clutch equipped with three interchangeable central bearing plates (convex, concave and flat types) reported that when pantographic tracings were made, as long as the stylus direction with the tracing surface was correct, even if the plate form was changed, the tracing always followed the same locus. Hayashi, using the above three central bearing plates, made measurements of mandibular movements by the chewing method. Using this data he fabricated TMJ articulator resin fossae and carefully studied their shapes. From this he concluded that even with different central bearing plate shapes, the resin fossa form remained the same.

If we assume the mandible is a rigid body, then we may consider its movements as being that of a three-dimensional triangle formed by the two condyles and the incisal point. If that is true we may also
think that changes in the path of movement of the incisal point have an effect on the left and right condylar paths.

The purpose of this study was to analyze two-dimensionally in the sagittal plane by investigating the Fischer angle, what type of effect anterior guidance has on posterior guidance.

For the purpose of studying how anterior guidance resulting from incisal guidance affects and correlates with condyle controlled posterior guidance, a configuration corresponding to a typical pattern of anterior guidance was reproduced using a central bearing plate. This paper deals with the significant information obtained concerning the Fischer angle when a two dimensional analysis was performed on the effects imparted on condylar movements using this apparatus.

MATERIALS AND METHODS

For this study five Japanese males between the ages of 20 and 30 with subjectively and objectively normal occlusion were selected. Using alginate impressions, maxillary and mandibular dental plaster models were prepared and mounted on a Gnathomatic articulator using a TMJ hinge bow. The surveyed hinge was used for posterior reference points, and a point on the skin surface 43mm above the incisal edge of the left central incisor was used as the anterior reference point. The mandibular cast was mounted in centric position (maximum retrusive position) using a centric bite core. In order to increase the accuracy, the centric bite was taken three times using a Lucia anterior jig and it was checked by the split cast method.

A Denar clutch former was used for making the clutches. After adapting aluminum foil to the occlusal surfaces of the maxillary and mandibular casts, a thin layer of vaseline was applied as a separating medium. Next, mixed resin was applied to the upper and lower clutch former surfaces and it was fixed to the plaster models. At this time care was taken to align the clutch inclination parallel to the occlusal surfaces and, in order to insure an appropriate resin thickness, the articulator vertical intermaxillary distance was fixed. After the resin had hardened, the stabilizing screw was loosened and the clutch former and maxillary clutches were removed. Then different shaped bearing plates were mounted using the mandibular clutch surface as a guide. In this manner clutches were made with the three types of bearing plates without changing the articulator intermaxillary vertical dimension.

The three types of bearing plate configuration are: 1) the Denar standard type (hereafter referred to as the Denar plate), 2) the Stuart type (hereafter referred to as the Stuart plate), and 3) the flat plate (Fig. 1). The flat plate was molded by adapting a Miro-Silver cast die on a Stuart plate former. The central bearing screw contact point was fixed for each clutch and care was taken not to create a change in the intermaxillary vertical dimension even when
the clutches were interchanged.

First, the clutch with the flat plate was tried in the mouth and the screw height was adjusted so the clutches would not hit during eccentric movements. The clutch was then returned to the articulator and the incisal pole was fixed with the central bearing screw remaining in contact with the bearing plate. Then, the maxillary clutches with different shaped plates were interchanged and the fact that the intermaxillary distance had not changed was confirmed (Fig. 2).

The measurements were carried out as follows. After the maxillary and mandibular clutches were fixed to the subject's dentition, the mandibular cross bar was attached to the mandibular clutch. Then a quick analyzer type side arm equipped with a microadjust crosspiece was attached. Since the side arm stylus is extremely sharp, it is possible to obtain a tracing with a very fine line. The subject's mandible was guided into centric position and fine adjustments were then made in order to cause the side arm stylus tip to point to the hinge mark. Then the Stuart ear flag was fixed to the subject's head. Care was taken at this time to place the flag as near as possible to the surface of the subject's skin. For this reason, the position of the stylus used in this experiment was in a position considerably more medial than in previous pantographs. Denar pressure sensitive paper was fixed to the condyle area of the flag and care was taken to align the paper as near as possible with the horizontal reference plane (Fig. 3,4).

In this manner, protrusive and lateral excursions were carried out and the pressure of the stylus traced out the loci on the paper. After the tracing was made, only the maxillary clutch was replaced and the tracing was performed again. In this way using each of the three types of central bearing plates on each subject, protrusive
and lateral movement loci were recorded corresponding to the three types of plates (three sets on each side for a total of six sets) (Fig. 5, 6). The tracings for each of the subjects were removed from the flags, arranged, fixed to a board, photographed using a panacopy and slides were produced. At this time, in order to photograph each subject’s data at the same scale, a 20mm reference was incorporated with the picture. These slides were then projected perpendicularly at a magnification of 10x using a slide projector and the loci were traced on graphpaper. The measurements were all carried out at the same scale. The graphpaper horizontal axis was the horizontal reference plane, the vertical axis was the frontal plane and the intersection of these two was fixed at centric position.

RESULTS

Fig. 7 shows a typical tracing. Fig. 8, 9 and 10 show the protrusive and lateral condylar paths in the sagittal plane made with each of the three different types of the plates. Table 1 shows the Fischer
Fig. 7. Typical tracing

--- Stuart ---
--- Denar ---
--- Flat ---

X Y

Fig. 8. The protrusive (P) and lateral (L) condylar paths in the sagittal plane with the Stuart type plate. (Scale: mm)

Fig. 9. The protrusive (P) and lateral (L) condylar paths in the sagittal plane with the Denar type plate. (Scale: mm)
The Effect of the Central Bearing Plate Form on the Fischer Angle

Fig. 10. The protrusive (P) and lateral (L) condylar paths in the sagittal plane with the flat type plate. (Scale: mm)

DISCUSSION

Table 1. The Fischer angle for each subject

<table>
<thead>
<tr>
<th>Case No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>MEAN</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>STUART</td>
<td>9.0°</td>
<td>12.5°</td>
<td>8.0°</td>
<td>7.5°</td>
<td>2.0°</td>
<td>0.0°</td>
<td>9.0°</td>
</tr>
<tr>
<td>DENAR</td>
<td>15.0°</td>
<td>17.0°</td>
<td>6.5°</td>
<td>17.2°</td>
<td>27.0°</td>
<td>4.5°</td>
<td>0.0°</td>
</tr>
<tr>
<td>FLAT</td>
<td>0°</td>
<td>7.5°</td>
<td>9.0°</td>
<td>16.0°</td>
<td>12.0°</td>
<td>1.0°</td>
<td>3.0°</td>
</tr>
</tbody>
</table>

angles obtained from the total of 30 tracings (6 for each of the five subjects). From this the following was concluded:
1. The Fischer angle was observed in almost all the tracings.
2. Among the 30 tracing, 5 showed a Fischer angle of 0° and of these 3 had used the Stuart plate.
3. The Fischer angle was greatest using the Denar plate and smallest using the Stuart plate. The flat plate gave values between these two. The average values for the Fischer angle were 11.02° with the Denar plate, 7.3° with the flat plate, and 5.5° with the Stuart plate.
4. During this study a minus Fischer angle (an angle of less than 0°) was not seen.

Fig. 11 shows the results obtained from the investigation of the inclination of the clutch central bearing plate used in this study with respect to the occlusal plane. Impressions were taken of the surfaces of the three types of central bearing plates using silicone impression material (Fig. 12). The impressions were cut along the locus formed by the movement of the central bearing plate during measurements (the gothic arch), and the angle it forms with the base (the occlusal plane) was measured. For the inclination angle
the region containing the movement of the screw (shadowed area of the graph) was measured. From this it can be seen that the difference between the protrusive and lateral movement paths at the plate surface (the bearing plate "Fischer angle") is 3° for the Denar plate, and 0° for the Stuart and flat plates. In other words, as far as the bearing plate "Fischer angle" is concerned, the Stuart and flat plates can be considered to be the same thing. However, with the Stuart plate there is a 16° inclination between the protrusive and lateral movement paths.

Data obtained from this study can be divided and analyzed into the following two areas:

1. The effect of the bearing plate "Fischer angle" and,
2. the effect of the central bearing plate sagittal movement path.

The reason the average value with the Denar plate is so high (11.02°) is thought to lie in the fact that a central bearing plate "Fischer angle" of 3° is imparted with this device. The difference between the Fischer angle measured with the Denar plate (11.02°) and the average of the angles measured with the Stuart and flat plates ((5.5° + 7.3°)/2 = 6.4°) which have a 0° central bearing plate "Fischer angle" is 11.02° − 6.4° = 4.62°. This 4.6° difference can be thought to arise from the 3° central bearing plate "Fischer angle" of the Denar plate. From the above it can probably be concluded that, "if there is a difference in the bearing plate lateral and protrusive movement paths, this effect will appear in the Fischer angle and if this difference is large the Fischer angle will be large."
Since the central bearing plate "Fischer angle" is $0^\circ$ for both the Stuart and flat plates, the $1.8^\circ$ difference in the measured Fischer angle can be considered to appear due to influences of the condyle itself. This difference has probably been caused by the $16^\circ$ difference in the inclination with respect to the sagittal plane between the former and the latter.

The sagittal path has an average inclination of $35^\circ$ to $45^\circ$. For this reason the angle the Stuart plate forms with the sagittal path is small and, on the other hand, the angle formed by the flat plate is large. Since the cusps of the molars have a tendency to become shallower as the sagittal condyle path and sagittal incisal path become more parallel, it is thought that the Fischer angle using the Stuart plate may also become smaller. From the above it can be concluded that, "the Fischer angle will become smaller as the condyle path and central bearing angle become more parallel."

It is thought that the reason there was a large variation in the standard deviations of this data lies in the fact that the subjects' condyle path inclination angles varied widely. For this reason it is conjectured that even if the number of subjects were increased, stable results would not be obtained.

CONCLUSION

Five subjects having subjectively and objectively normal occlusion were selected and their Fischer angles were measured using three types of clutches with different shapes (Stuart, Denar and flat plates). In the results it became clear that the Fischer angle changed with different central bearing plate forms. The Denar plate has, with respect to the occlusal plane, a $15^\circ$ protrusive and an $18^\circ$ lateral movement inclination, making a $3^\circ$ difference between the two. For this reason, when this type of plate was used the Fischer angle was largest. The Stuart plate has a $16^\circ$ inclination in both the protrusive and lateral movement paths with respect to the occlusal plane. For this reason, the difference between the two (the central bearing plate "Fischer angle") was $0^\circ$. However, since the inclination of the Stuart plate was closest to being parallel to the sagittal condyle path, when it was used the Fischer angle was smallest. The flat plate has an inclination of $0^\circ$ with respect to the occlusal plane and the difference between the protrusive and lateral movement paths is $0^\circ$. However, since this plate has a larger inclination with respect to the sagittal condyle path, it gives a larger Fischer angle value than the Stuart plate.

From the above, the following conclusions were obtained:
1. The Fischer angle exists.
2. The Fischer angle changes as a result of the influence of anterior guidance.
3. If there is a difference in the lateral and protrusive movement paths of the central bearing plate, this effect appears in the Fischer angle and, if this difference is large, the angle will
become larger.
4. If the condyle path and central bearing plate inclinations are parallel, the Fischer angle will be small.

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REFERENCES


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