A Roentgenographic Study of the Temporomandibular Joint Using a Special Head Positioner

WILLIAM L. LAWTHER, D.D.S.
Cleveland, Ohio

This study was conducted in an effort to learn more about the normal articulation of the temporomandibular joint. Standardized roentgenograms were made of the temporomandibular joints on three groups of individuals. The first group was comprised of eleven white men between the ages of 20 and 30 years, each of whom had a good complement of natural teeth (26 or more) in a Class I articulation (Angle Classification). The second group of eleven white men ranged between 30 and 40 years of age and also possessed a good complement of natural teeth in Class I articulation. A comparison of the results of these two groups was made to see if there was any significant difference between the two groups in the temporomandibular joint articulation. The third group was made up of edentulous individuals who had been wearing full upper and lower dentures for over three years. In addition to the three groups of normals, eighteen patients who complained of temporomandibular joint disturbances were radiographed. These patients were evaluated and compared with the normals or standards. Several of these patients were followed serially with records being made before, during, and after treatment.

AIMS

The purpose of this study was threefold. First, to study and measure the temporomandibular joint in a group of people who have a good complement of teeth in normal articulation. This was done to see if standards could be established in the relationship of the condyle to the glenoid fossa. Second, to determine the practicality of the standards as an aid in diagnosing patients with temporomandibular joint disturbances. Third, to test the accuracy of the head positioner in following a patient serially with roentgenograms of the temporomandibular joint, before, during, and after treatment.

METHOD

All the radiographs of the temporomandibular joint of the normals, and the radiographs of patients with temporomandibular joint disturbances, were made with the person's head positioned in a special head positioner (Figure 1) adapted to a Broadbent-Bolton cephalometer.[1] The head positioner places each patient's head in exactly the same relationship to the x-ray tube and the x-ray film. It holds the head in position by means of ear rods inserted in each ear and a nasion rest attachment which can be held firmly against the bridge of the nose (Fig. 2). The patient's head is tilted so that the central ray of the x-ray tube enters the head above and behind the ear and leaves the head through the external acoustic meatus on the side being radiographed (Figure 3). The head is tilted so that the central ray of the x-ray tube is parallel to the average angulation of the long axis of the mandibular condyle[2] (Figure 4).

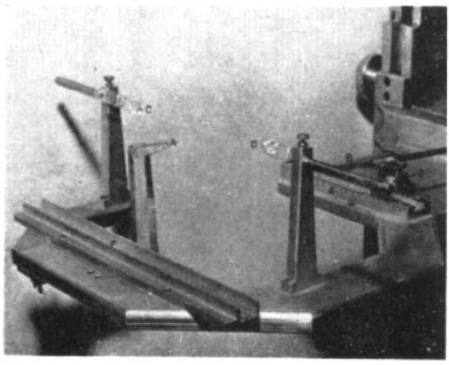

Fig. 1 Temporomandibular joint head positioner
A. Stationary ear rod
B. Adjustable ear rod
C. Nasion rest attachment used when making radiographs of the left side
D. Nasion rest used for the right side
E. Millimeter scale
F. Film cassette channel
G. Supporting base for the adjustable ear rod

The target-film distance is 68½ inches, which for all practical purposes eliminates enlargement and distortion in the roentgenograms of the parts being radiographed (Figure 5). This makes possible the use of orbitale, porion, the superior surface of the sphenoid bone, and the posterior border of the ramus, as reference and orientation points.

Four roentgenograms were made of each temporomandibular joint on each person radiographed. One was made with the patient in centric occlusion, two with the patient in the physiologic rest position, and one with the jaws opened as far as possible. After experimentation with various methods of obtaining a physiologic rest position, the most constant results were obtained by making the roentgenograms after

Fig. 2 An individual positioned for a radiograph of the right temporomandibular joint

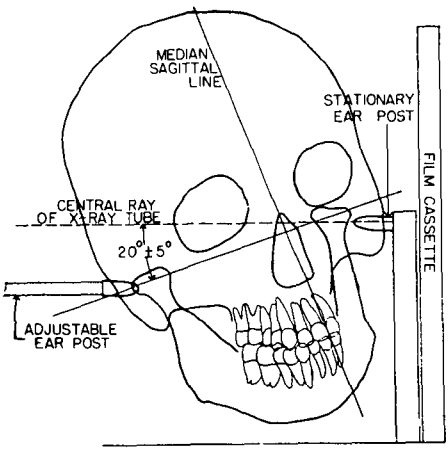

Fig. 3 Frontal aspect, relationship of the central ray of the x-ray tube to the head of the mandibular condyle.

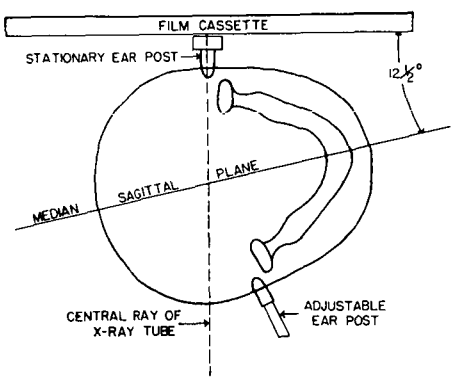

Fig. 4 Superior aspect, relationship of the central ray of the x-ray tube to the head of the mandibular condyle.

the patient had swallowed and then relaxed his lower jaw. However, in order to be as accurate as possible in radiographing the temporomandibular joint articulation at the physiologic rest position, two roentgenograms were made with the mandible in this position. The resulting roentgenograms of the joint articulation were very constant and in no instance was there enough difference that one or the other could be considered faulty or unusable. The measurements of these two roentgenograms were averaged for further accuracy.

A tracing was made of each temporomandibular joint roentgenogram (Figures 5 and 6). Four linear measurements and two angulations were read and recorded from each tracing. The

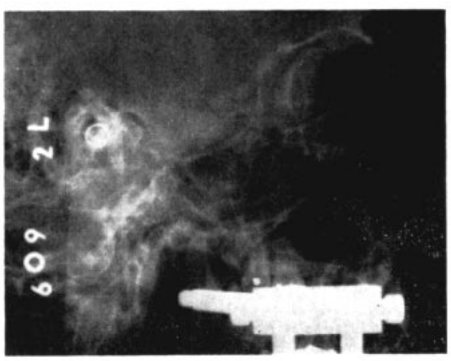

Fig. 5 Temporomandibular joint radiograph

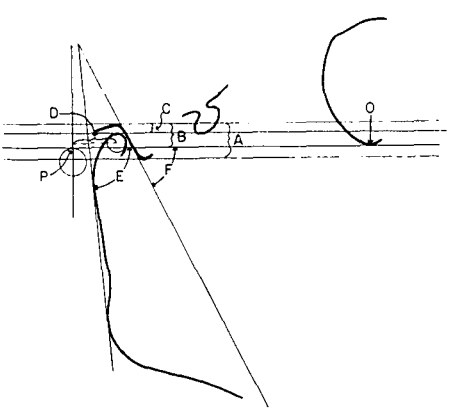

Fig 6 Tracing of a temporomandibular joint radiograph showing the various measurements made in the assessment.

A. Fossa height
B. Porion to fossa height
C. Top of condyle to fossa height
D. Porion to the center of the condyle
E. Angulation of the ramus to the porion-orbitale line
F. Angulation of the slope of the articular eminence to the porion-orbitale line
O. Orbitale
P. Porion

structures traced were the glenoid fossa, the head of the condyle and the posterior border of the ramus, the superior surface of the sphenoid bone, the outline of the orbit on the side being radiographed, and the porion point. The ear rod used on the side being radiographed has a metal ring imbedded in it which shows up on the roentgenogram, and the most superior point is porion. The lowest point on the outline of the orbit is the orbitale point and a line is drawn from it to porion. This is the reference line used in making the measurements and angulations. Three lines are drawn on the tracing parallel to the porion-orbitale line. One line is drawn from the highest point on the inner surface of the glenoid fossa, one from the highest point on the condyle, and one from the lowest point of the articular eminence. Two other lines are drawn on the tracing; one tangent to the posterior border of the mandibular ramus and one tangent to the straightest portion of the articular eminence.

Recorded Measurements and Angulations

Fossa Height

"A" in Figure 7. The distance between two parallel lines, one of which is drawn from the most superior point on the inner surface of the glenoid fossa and the other from the most inferior point of the articular eminence.

Distance from the porion-orbitale line to the most superior point on the inner surface of the glenoid fossa

"B" in Figure 7. The distance between two parallel lines, one of which is drawn from the most superior point on the inner surface of the glenoid fossa and the other from porion to orbitale.

Distance from the most superior point on the head of the condyle to the most superior point on the inner surface of the glenoid fossa

"C" in Figure 7. The distance between two parallel lines, one of which is drawn from the most superior point of the inner surface of the glenoid fossa and the other from the most superior point on the head of the condyle.

Distance from porion to the center of the condyle

"D" in Figure 7. A line is drawn perpendicular to the porion-orbitale line at porion and the distance between this line and the center of the head of the condyle is measured parallel to the porion-orbitale line. The center of the head of the condyle is determined by inscribing as large a circle as possible in the head of the condyle and using the center of this circle as the reference point.

Angulation of the ramus to the porion-orbitale line

"E" in Figure 7. The angle formed by the junction of the porion-orbitale line and the line drawn tangent to the posterior border of the mandibular ramus.

Angulation of the Slope of the articular eminence

"F" in Figure 7. The angle formed by the junction of the porion-orbitale line and a line drawn tangent to the straightest portion of the slope of the articular eminence.

Comparison of Temporomandibular Joint Articulation in 20 Year Age Group and 30 Year Age Group

Fossa height

There was no appreciable difference in the average height of the glenoid fossa between the 20 year and 30 year age groups. In both groups the range in the height of the fossa was from a little over 9 mm. to a little over 4 mm.

20 year age group 7.02 mm. ± 1.25
30 year age group 7.03 mm ± 1.67

Slope of the articular eminence

The slope of the articular eminence showed no appreciable difference between the 20 and the 30 year age groups.

20 year age group 55.25° ± 8.79
30 year age group 57.75° ± 11.70

Distance from most superior point on the head of the condyle to the most superior point on the inner surface of the glenoid fossa

These measurements of the position of the condyle in the glenoid fossa at the physiologic rest position, centric occlusion, and wide open jaw position show no appreciable differences between the 20 and the 30 year age groups.

Centric occlusion
20 year age group 2.72 mm. ± .82
30 year age group 2.50 mm. ± .84
Physiologic rest position
20 year age group 3.09 mm. ± .94
30 year age group 3.19 mm. ± 1.02

Distance from porion to the center of the condyle

This measurement of the position of the condyle in the glenoid fossa at centric occlusion and the forward movement of the condyle when opening to the physiologic rest position or the wide open jaw position shows no appreciable differences between the 20 year age group and the 30 year age group.

At centric occlusion
20 year age group 12.36 mm. ± 1.18
30 year age group 13.34 mm. ± 2.20
The forward movement from centric occlusion to physiologic rest position
20 year age group .29 mm. ± .52
30 year age group .57 mm. ± .73
The forward movement from centric occlusion to wide open jaw position
20 year age group 13.12 mm. ± 4.04
30 year age group 13.85 mm. ± 4.78

Angulation of the ramus to the porion-orbitale line

The angulation of the ramus to the porion-orbitale line showed no appreciable differences at the various positions between the 20 year age group and the 30 year age group.

At centric occlusion
20 year age group 78.27° ± 5.28
30 year age group 77.35° ± 5.33
The increase in the angulation at the physiologic rest position
20 year age group 1.07° ± 1.15
30 year age group 1.01° ± 1.20
The increase in the angulation at wide open jaw position
20 year age group 26.13° ± 7.21
30 year age group 23.79° ± 9.26

Discussion

The measurement of the movement of the condyle when the jaws are closed from the physiologic rest position to centric occlusion shows that in both age groups the average movement is in an upward and backward direction. The average movement of the condyle in the 20 year age group was .41 mm. ± .45 in an upward direction and .29 mm. ± .52 in a backward direction. The average condyler movement for the 30 year age group was .60 mm. ± .47 in an upward direction and .57 mm. ± .73 in a backward direction. In computing these averages the normal movement of the condyle was considered to be upward and backward when closing from the physiologic rest position to centric occlusion. When, in each individual joint, the condyle did move upwards and backwards, the extent of the movements were considered positive measurements. If the condyle moved downward or forward when closing from the physiologic rest position to centric occlusion, this movement was given a negative value and averaged accordingly in computing the average or median movements of the condyle.

In the 20 year age group, the condyle moved downward 7.94 mm. ± 1.40 and forward 13.12 mm. ± 4.04 when

opening the jaw from centric occlusion to as wide open as possible. In the 30 year age group, the condyle moved downward 5.10 mm. ± 1.90 and forward 13.85 mm. ± 4.78. It is interesting to compare in the same individual the forward movement of the condyle on one side to the forward movement of the condyle on the opposite side. The average difference in the extent of the forward movement between the two sides was 1.78 mm. with a range of 3.4 mm. to 0.1 mm. for the 20 year olds and an average difference of 2.1 mm. with a range of 3.6 mm. to 0.2 mm. for the 30 year olds.

When the jaws close from physiologic rest position to centric occlusion, there is an average decrease in the angle formed by a line drawn tangent to the posterior border of the mandible to the porion-orbitale line of slightly over 1°. This gives the illusion that there is a hinge action of the condyle in glenoid fossa during the closure from the physiologic rest position to centric occlusion. But accompanying this hinge like action there is an upward and backward movement of the condyle in the fossa so it isn't a true hinge action.

There was so little difference in the results of these two groups that it was decided to combine them and make the average measurements the standards for evaluating the patients with temporomandibular joint disturbances.

The 20 to 30 Year Age Group and the 30 to 40 Year Age Group Averaged Together

Fossa height

7.02 mm. ± 1.50

Slope of the articular eminence

56.50° ± 10.52

Distance from the most superior point on the head of the condyle to the most superior point on the inner surface of the glenoid fossa

Centric occlusion

2.61 mm. ± .85

Physiologic rest position

3.12 mm. ± .88

At a wide open jaw position

7.86 mm. ± 1.74

Distance from porion to the center of the condyle at centric occlusion

12.95 mm. ± 1.62

Movements of the condyle

From physiologic rest position to centric occlusion

.50 mm. ± .48 upward

.43 mm. ± .66 backward

From a wide open jaw position to centric occlusion

5.25 mm. ± 1.77 upward

13.49 mm. ± 4.48 backward

Angulation of the ramus to the porion-orbitale line

At centric occlusion

77.83° ± 5.23

The increase in the angulation at physiologic rest position

1.05° ± 1.17

The increase in the angulation at wide open jaw position

24.96° ± 8.50

Discussion

These figures bear out the contentions of Ricketts[3] and Thompson[4] that the movement of the mandible from the physiologic rest position to centric occlusion is practically a hinge action with the axis of the hinge being located in the head of the condyle or slightly lower. They both stated that they were able to detect some movement of the condyle in the fossa in most cases so it isn't a true hinge action. Thompson called it, "almost a hinge movement." A very slight movement of the head of the condyle was measurable in all the 44 joints used in this study. This movement varied from as little as .05 mm. to as much as 2.00 mm. The average movement was .50 mm ± .48 upward and .43 mm. ± .66 backward.

A question was brought up near the

completion of this study as to whether the results might be changed if the patients had been instructed to touch their teeth lightly in centric occlusion rather than being told to clench their teeth. Five dental interns were selected for the controls to see if there was any difference in the position of the condyle in the glenoid fossa in the two positions. They were selected because all five had normal Class I articulations with at least 28 teeth present and no evidence of premature contacts. In not one of the 10 joints was there any measurable difference in the relative position of the condyle in the fossa in the two methods of obtaining a centric occlusion position. This contradicts the belief of some dentists that when the jaws are clenched together there is an accompanying pressure of the condyle in the glenoid fossa.

The Temporomandibular Joint Measurements on 10 Edentulous Patients

The temporomandibular joints were roentgenographed on 10 persons who had been wearing dentures for more than three years. Some had been wearing dentures for as long as 10 to 15 years. The same measurements and angulations were made on the tracings of their roentgenograms that were done on the other groups. The following results were obtained and compared to the standards:

Fossa height

The height of the glenoid fossa was less in the edentulous group than in the standard group.

standard group 7.02 mm. ± 1.50
edentulous group 6.85 mm. ± 2.95

Slope of the articular eminence

The slope of the articular eminence was less in the edentulous group than in the standard group.

standard group 56.50° ± 10.52
edentulous group 52.64° ± 11.62

Distance from the most superior point on the head of the condyle to the most superior point on the inner surface of the glenoid fossa

The mandibular condyle was positioned higher in the fossa in the edentulous group than in the standard group, especially at the physiologic rest position.

At centric occlusion
standard group 3.12 mm. ± .88
edentulous group 2.43 mm. ± .92
At physiologic rest position
standard group 2.61 mm. ± .85
edentulous group 2.47 mm. ± .94
At a wide open jaw position
standard group 7.86 mm. ± 1.74
edentulous group 6.40 mm. ± 2.94

Distance from porion to the center of the condyle at centric occlusion

The condyle is more posterior in the fossa in the edentulous group than it is in the standard group.

Standard group 12.95 mm. ± 1.62
Edentulous group 12.47 mm. ± 1.96

Movements of the condyle

The movements of the condyle in the edentulous group varied considerably with the movements of the condyle in the standard group. In the standard group, the movement of the condyle was upward and backward when the patient closed from the physiologic rest position to centric occlusion. In the edentulous group, this movement was downward and backward. The upward and backward movement of the condyle when the patient closed from the wide open jaw position to centric occlusion, was considerably less in the edentulous group than in the standard group.

From the physiologic rest position to centric occlusion
standard group
.50 mm. ± .48 upward
.43 mm. ± .66 backward

edentulous group
.04 mm.± .33 downward
.19 mm. ± .40 backward
From a wide open jaw position to centric occlusion
standard group
5.25 mm. ± 1.77 upward
13.49 mm. ± 4.48 backward
edentulous group
3.97 mm. ± 2.79 upward
11.45 mm. ± 4.93 backward

Angulation of the ramus to the porion-orbitale line

The angulation of the ramus to the porion-orbitale line in centric occlusion was considerably less in the edentulous group than it was in the standard group. The amount of change in the angulation when the patient opened to the physiologic rest position and a wide open jaw position, was very similar in both groups.

At centric occlusion
standard group 77.83° ± 5.23
edentulous group 72.97° ± 6.41
The increase in the angulation at the physiologic rest position
standard group 1.05° ± 1.17
edentulous group 1.83° ± 1.27
The increase in the angulation at wide open jaw position
standard group 24.96° ± 8.50
edentulous group 24.43° ± 6.06

Discussion

The measurement of the fossa height and the angulation of slope of the articular eminence to the porion-orbitale line were less in the edentulous group than they were in the standard group. However, both of these findings in the edentulous group fell within the range of the standard of deviation of the standard group. The measurements that varied the greatest in comparing the edentulous group to the standard group were the measurement of the condyle in the fossa at the physiologic rest position, the angulation of the ramus to the porion-orbitale line in centric occlusion, and the measurements of the movements of the condyle when the patient opened to the physiologic rest position and a wide open jaw position.

The angle formed by a line tangent to the posterior border of the ramus to the porion-orbitale line, with the jaws in centric occlusion, is less in the edentulous group than it is in the standard group. This could mean that in edentulous individuals the vertical dimensions of the face in centric occlusion decrease as bone is resorbed due to the wearing of dentures. The difference in this angulation in the edentulous group between the physiologic rest position and centric occlusion is very close to the difference in the two positions in the standard group. Therefore, when there is a decrease in the vertical dimension in centric occlusion in the edentulous group there must also be a decrease in the vertical dimension of the edentulous individual in the physiologic rest position for the angular difference of these two positions to be so similar to the standard group.

The greatest differences between the standard and the edentulous groups were in the measurements of the movements of the condyle when the patient opened to the physiologic rest position and a wide open jaw position. In the normal group the condyle moved upward when the patient closed from the physiologic rest position to centric occlusion. In only six of the 44 joints measured (13½ per cent) was there a downward or negative movement. In the edentulous group, the average movement of the condyle was downward when the person closed from the physiologic rest position to centric occlusion. In eleven of the 20 joints measured (55 per cent) there was a downward movement of the condyle.

There was not as much posterior movement of the condyle in the edentulous group when the patient closed from the physiologic rest position to centric occlusion.

Summary

At the beginning of the study it was realized that if the standards were to be of any practical value, they must prove useful in evaluating patients with temporomandibular joint disturbances. The measurements and angulations for the standard group showed that there was a high degree of uniformity in the relationship of the condyle to the glenoid fossa and also in the extent of the movements of the condyle. A comparison of the edentulous group to the standard group showed that although there were differences, they were small and within a standard deviation of the standard group. The greatest difference between the two groups, the movement of the condyle when the patient closed from the physiologic rest position to centric occlusion, was not a difference that should cause temporomandibular joint discomfort. In the edentulous group, there was a downward movement of the condyle instead of an upward movement when the patient closed from physiologic rest position to centric occlusion. This would cause a decrease in the pressure of the condyle in the fossa and it is generally thought that an increase in the pressure will cause joint discomfort.

All the patients that complained of a temporomandibular joint disturbance were roentgenographed in the same manner as the standards and the measurements and angulations were compared to the standards. In as many cases as possible, these patients were followed roentgenographically through their courses of treatment to see if the treatment made any changes in the condyle to fossa relationships.

Evaluation of Patients With Temporomandibular Joint Disturbances

Eighteen patients appeared at the clinic complaining of temporomandibular joint disorders. Twelve of these had discomfort in both temporomandibular joints and six of them had unilateral discomfort. Most of their symptoms were very similar — pain around the joint, sometimes radiating down the jaw or the neck, pain worse in the morning or after eating, crepitation in the joint on opening, and some nausea and dizziness. Most of these patients were referred to the clinic for an evaluation and the recommendations were sent back to the referring dentist. This made it difficult to follow the patient's progress after treatment.

The most outstanding difference in comparing the measurements of these patients' temporomandibular joints to the standards was the condyle to fossa measurement ("C" in Figure 7). This is the measurement of the distance between the highest point on the condyle to the most superior point on the inner surface of the glenoid fossa. The average distance between these two points for the standards in centric occlusion was 2.61 mm. In 18 out of the 30 joints giving discomfort, the measurement was under 2.0 mm. In only one of the joints giving discomfort was the distance greater than the average for the standards. In 18 of the 30 joints the movement of the condyle from the physiologic rest position to centric occlusion exceeded the average movement found in the standards, which was .50 mm. $\pm$ .48 in an upward direction and .43 mm. $\pm$ .66 in a backward direction.

From the comparisons of the painful temporomandibular joints to the average joints, it appears that in the majority of the disturbed joints the condyle to the glenoid fossa measurement is smaller in centric occlusion than in the

standards. Also, the movement of the condyle from the physiologic rest position to centric occlusion is greater in an upward and backward direction than in the average joints.

This was borne out in several patients who could be followed before, during, and after treatment.

Case Report

A 42 year old woman came to the clinic for treatment of a temporomandibular joint disturbance which had been present for from 6 to 8 months. The pain was on the left side only and was worse after mastication. She had no history of bruxism, arthritis, or loss of hearing. She had quite a few of the permanent teeth missing with prosthetic appliances replacing them. The only molars present were the upper left second and third molars, the upper right second molar, and the lower right third molar. She had retained her upper bicuspids, but in her lower jaw, only the lower left second bicuspid remained.

The cephalometric roentgenographic appraisal showed that her path of closure was in the normal upward and forward direction from the physiologic rest position to centric occlusion. The freeway space was within the normal limits measuring 2.5 mm. in the anterior section of her mouth.

A measurement of the temporomandibular joint roentgenograms revealed that the distance between the condyle and the glenoid fossa was 1.0 mm. on the left side, which is 1.6 mm. smaller than the average. This measurement of the right joint was smaller than the average. It was 2.2 mm. but was not as deficient as the left side which was the painful side.

After examining her mouth, it was felt that her centric occlusal relationship was faulty because of the prosthetic appliances. She had quite a few defective fillings. These were replaced to their normal contour and a lower partial denture was constructed to replace the missing lower bicuspids and molars. This corrected her centric occlusal relationship and made a noticeable change in the temporomandibular joint measurements which relieved the temporomandibular joint discomfort. It increased the condyle fossa measurement on the left side from 1.0 mm. to 2.7 mm. in centric occlusion. The measurement on the right side remained unchanged. There was quite a change in the porion to condyle measurements in centric occlusion after the insertion of the new partial denture ("D" in Figure 7). The right side increased from 15.3 mm. to 18.0 mm. and the left side decreased from 16.4 mm. to 14.7 mm. The faulty centric occlusal relationship caused the right condyle to be forced back in the fossa and the left condyle to be pulled forward. On the left side, the discomfort was caused by the condyle being too high in the fossa and too far forward in centric occlusal relationship, causing pressure in the glenoid fossa and on the slope of the articular eminence. The movements of the two condyles from physiologic rest position to centric occlusion are now within the normal limits found in the standard group.

Since the insertion of the new denture three months ago, there has been no recurrence of the pain in the left temporomandibular joint.

Case Report

A 24 year old woman reported to the dental clinic with a temporomandibular joint discomfort on the right side which had been present for over one year. The pain was quite severe after mastication. She had also noticed some loss of hearing in her right ear and had numerous dizzy spells with heavy salivation and nausea. She usually slept on her right side. She had no history of arthritis and did not remem-

ber any traumatic injury that could have precipitated her trouble.

A cephalometric roentgenographic examination showed her path of closure from the physiologic rest position to centric occlusion to be in the normal upward and forward direction. The measurement of the freeway space was small—1.8 mm. in the anterior section of her mouth.

A measurement of the temporomandibular joint roentgenograms showed the distance between the condyle and the top of the glenoid fossa in centric occlusal position to be less than average. The average is 2.61 mm. but this patient had 2.3 mm. on the right side and 2.5 mm. on the left side.

A latex splint was constructed to cover the occlusal surfaces of the lower posterior teeth, which she has now worn for several months. It has given her a great deal of relief from the temporomandibular joint discomfort. It is less than 1.0 mm. thick but it caused a measurable change in the temporomandibular joint articulation. It increased the distance between the condyle and the top of the glenoid fossa in centric occlusion from 2.3 mm. to 2.9 mm. on the right side and on the left side from 2.5 mm. to 2.9 mm. It also decreased the distance from porion to the center of the condyle in centric occlusal position from 10.9 mm. to 10.5 mm. on the right side and increased the distance on the left side from 7.7 mm. to 8.9 mm. In this patient's case, as in the previous one, the discomfort was caused by the condyle being too high in the fossa and too far forward which caused pressure in the glenoid fossa. The latex splint will be replaced with crowns and onlays.

Case Report

A 22 year old man was examined in the dental clinic for complaints of a temporomandibular joint disturbance on the left side. He was a well developed man with a full complement of teeth in a normal Class I articulation. The cephalometric appraisal revealed that he had a very small freeway space, measuring .89 mm. in the anterior section of his mouth. His path of closure was slightly upward and backward. This was especially evident in the roentgenogram of the left temporomandibular joint where a movement of the condyle of 1.1 mm. was measured in an upward direction when the patient closed from the physiologic rest position to centric occlusion.

It was felt that the abnormal closing movement was caused by prematurities in his occlusion and an occlusal equilibration was performed. This relieved the temporomandibular joint discomfort. A comparison of the cephalometric examinations, before and after treatment, showed a decrease in the vertical dimension in centric occlusion of .51 mm. This created an increase in the freeway space which measured 1.40 mm. after treatment. The occlusal equilibration corrected the path of closure so that it is now in the normal upward and forward direction from the physiologic rest position to centric occlusion.

A comparison of the temporomandibular joint measurements, before and after treatment, showed considerable change on the disturbed left side and no appreciable change on the normal right side. The right side, before treatment, was within the normal limits of the standards. The left side showed a large amount of upward movement in the condyle, before treatment, when the patient closed from the physiologic rest position to centric occlusion. As stated before, the amount of this movement was 1.1 mm. Before treatment the distance from the most superior point on the head of the condyle to the most superior point on the inner surface of the glenoid fossa was 2.7 mm. on the left side. After treatment it meas-

ured 3.2 mm. After treatment the movement of the left condyle from the physiologic rest position to centric occlusion was within normal limits.

The occlusal equilibration in this case relieved the temporomandibular joint discomfort on the left side by allowing the condyle to remain lower in the fossa in centric occlusion. The occlusal prematurities evidently caused the left mandibular condyle to be driven up higher in the fossa than normal, causing the discomfort. In the four months since the occlusal equilibration was performed there has been no recurrence of the discomfort.

Discussion

The measurements of the standards were helpful in evaluating the temporomandibular joints of patients who were experiencing joint discomfort. In the majority of the disturbed joints, the condyle was higher in the fossa than in the normal and there was a greater upward and backward movement of the condyle when the patient closed from the physiologic rest position to centric occlusion.

In the three cases described in this paper, the patients received relief from the temporomandibular joint discomfort when the measurements of their roentgenograms showed that the condyle to fossa relationship had been corrected to fall within the normal limits of the standards. This was accomplished by rehabilitating their mouths with proper prosthetic appliances, properly restored carious teeth, crowns and onlays, and occlusal equilibration.

Summary

In this study, the following three objectives were accomplished:

1. Standards of the relative position of the condyle to the glenoid fossa were established by measuring the temporomandibular joint roentgenograms of 22 individuals who had 26 or more teeth in normal Class I articulation. All of these individuals were well developed and exhibited neither retrognathic nor prognathic tendencies.
2. These standards were used in the evaluation of patients with temporomandibular joint disturbances. When the condyle to glenoid fossa relationships were brought back within the normal limits by equilibration or mouth rehabilitation, their temporomandibular joint discomforts disappeared.
3. The head positioner proved to be very accurate in fixing the patients' heads in a standard relationship to the x-ray tube and the x-ray film. This made it possible to make serial roentgenograms of a patient, before, during, and after treatment, and to follow the changes in the temporomandibular joint articulation resulting from the treatment.

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