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Condylar Guidance: Correlation between Protrusive Interocclusal Record and Panoramic Radiographic Image: A Pilot Study

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Abstract

Purpose: The purpose of this study was to compare the sagittal condylar angles set in the Hanau articulator by use of a method of obtaining an intraoral protrusive record to those angles found using a panoramic radiographic image.
Materials and Methods: Ten patients, free of signs and symptoms of temporomandibular disorder and with intact dentition were selected. The dental stone casts of the subjects were mounted on a Hanau articulator with a springbow and poly(vinyl siloxane) interocclusal records. For all patients, the protrusive records were obtained when the mandible moved forward by approximately 6 mm. All procedures for recording, mounting, and setting were done in the same session. The condylar guidance angles obtained were tabulated. A panoramic radiographic image of each patient was made with the Frankfurt horizontal plane parallel to the floor of the mouth. Tracings of the radiographic images were made. The horizontal reference line was marked by joining the orbitale and porion. The most superior and most inferior points of the curvatures were identified. These two lines were connected by a straight line representing the mean curvature line. Angles made by the intersection of the mean curvature line and the horizontal reference line were measured. The results were subjected to statistical analysis with a significance level of $p < 0.05$.
Results: The radiographic values were on average 4° greater than the values obtained by protrusive interocclusal record method. The mean condylar guidance angle between the right and left side by both the methods was not statistically significant. The comparison of mean condylar guidance angles between the right side of the protrusive record method and the right side of the panoramic radiographic method and the left side of the protrusive record method and the left side of the panoramic radiographic method ($p = 0.071$ and $p = 0.057$, respectively) were not statistically significant.
Conclusion: Within the limitations of this study, it was concluded that the protrusive condylar guidance angles obtained by panoramic radiograph may be used in programming semi-adjustable articulators.

Condylar guidance is defined as the mandibular guidance generated by the condyle and articular disk traversing the contour of the glenoid fossae.[1] The correlation between the path traced by the condyle during mandibular movements and the morphology of the occlusal surfaces has been studied by various investigators.[2-5] A protrusive interocclusal record can register the influence of condylar paths over the movements of the mandible. It enables the condylar guidances of the articulator to be set to an approximation of the paths of the condylar movements in patients.[6] Several investigators have studied the accuracy of these interocclusal records.[7-15] There has been unreliability of recording and reproducing the condylar guidance on semi-adjustable articulators.[16-19] Consecutive condylar guidance angles recorded showed variation between operators, between recording materials, and between articulators.[20,21] Panoramic radiography is widely used for diagnosis. Gilboa et al, through their study on 25 dry human skulls, determined that the radiographic outline of articular fossa and articular eminence in a panoramic radiographic image is an accurate representation of equivalent outlines in the skull and can be of value in determining condylar guidance angles.[22]

The purpose of this study was to compare the sagittal condylar guidance angles found in panoramic radiographic images to

Figure 1 Patient positioned for panoramic radiograph.

Figure 2 Superior and inferior points marked in panoramic radiograph.

the values set on a Hanau articulator by protrusive interocclusal record.

Materials and methods

The study was approved by Narayana Dental College and Hospital Institutional Ethical Committee (NDC/2010–11/EC/2010). Ten patients with intact dentitions with no signs or symptoms of temporomandibular disorders were selected for the study.

Irreversible hydrocolloid impressions (Zelgan, Dentsply, Noida, India) of each arch were taken of each patient and immediately poured in stone. The casts were mounted on an articulator (Hanau articulator Model Wide-Vue 183, Teledyne/Water Pik, Fort Collins, CO) with a springbow (Teledyne/Water Pik) and poly(vinyl siloxane) interocclusal records (Virtual CAD-bite Registration; Ivoclar Vivadent AG, Schaan, Liechtenstein). Each patient was instructed to move his/her mandible directly forward by approximately 6 mm, and a protrusive record was obtained. The condylar guidance angles recorded on the articulator were tabulated.

A panoramic radiographic image of each patient was made with the Frankfurt horizontal plane parallel to the floor of the mouth (Fig 1). All radiographs were made by the same operator at the same time with the same panoramic radiographic unit (Planmeca Promax; Helsinki, Finland). The images were acquired at 74 kVp and 10 Ma. The panoramic radiographic unit comes with a light aligned along the anatomic planes, and a cephalostat was used to align the head in the same position for all patients. Two radio-opaque lines are consistently apparent on the panoramic radiographs in the region of the temporal bone. One depicts the outline of the articular eminence and fossa, the second, the inferior border of the zygomatic arch. Tracings of the radiographic images were made. A horizontal reference line was marked by joining the orbitale and porion. The most superior and the most inferior points of the curvatures were identified (Fig 2). These two lines were connected by a straight line representing the mean curvature line (Fig 3). Angles made by the intersection of the mean curvature line and the horizontal reference line were measured (Fig 4). The data were subjected to statistical analysis by paired *t*-test.

Results

Table 1 shows the angles of the condylar guidance and standard deviations measured by the protrusive interocclusal record and panoramic radiographic methods. Table 2 shows the correlation between the condylar guidance angles measured by protrusive interocclusal record and panaromic radiographic image. The radiographic values were on average 4° greater than the values obtained by the protrusive interocclusal record method. The comparison of mean condylar guidance angles between the right side of the protrusive record method and the right side of the panoramic radiographic method and the left side of the protrusive record method and left side of the panoramic radiographic method ($p = 0.071$ and $p = 0.057$, respectively) were not statistically significant ($p < 0.05$).

Discussion

A panoramic radiograph provides the clinician with a comprehensive view of the entire maxillomandibular region, producing an image of both dental arches on a single film. Image magnification and distortion limit accuracy in panoramic radiography. The vertical dimension is less altered than the horizontal

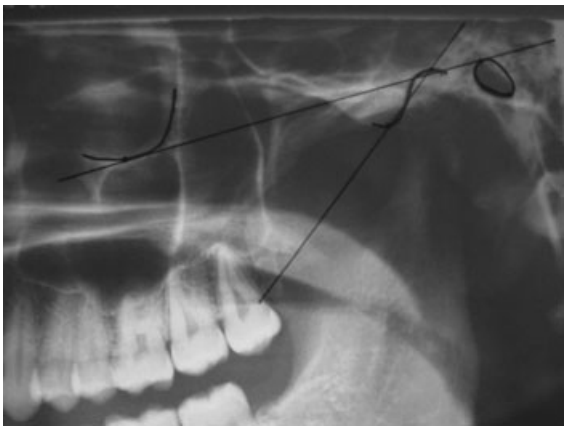

Figure 3 Horizontal reference line marked in panoramic radiograph.

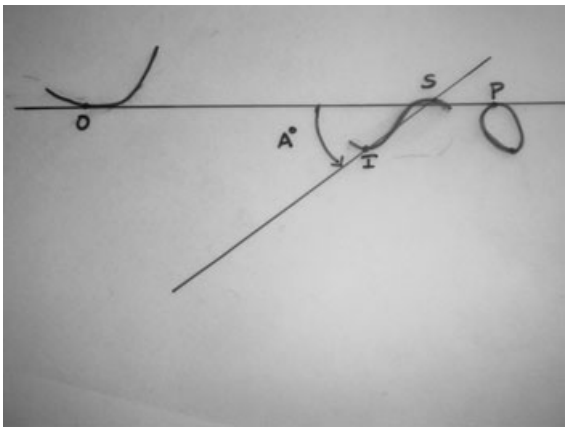

Figure 4 Tracing of line SI joining height of superior curvature and inferior curvature. OP is Frankfurt horizontal plane. A is the angle made by the intersection of the mean curvature line and horizontal reference line.

dimension. The distortions result from the horizontal movement of the film and X-ray source. If the degree of magnification was the same both horizontally and vertically in the central plane of the focal trough, all structures would be in focus on the final radiograph.[23-25]

A panoramic radiographic image in the temporal region shows the outer radio-opaque line depicting the articular eminence and inner radio-opaque line depicting the inferior border of the zygomatic arch. These lines often intersect and can be confusing due to significant limitations of panoramic radiographs imputable to distortions inherent in the panoramic system and errors in patient positioning.[23,24] Parallax errors may arise with positioning errors of the head to the exposure path. In the present study the panoramic machine comes with a light source and cephalostat that helps in accurate positioning of the patients, and the same machine was used to obtain all radiographs. The mean curvature of the articular eminence in the panoramic radiographic image was recorded as condylar guidance angle.

Table 1 Angles of condylar guidance and standard deviation (SD) measured by protrusive interocclusal record and panoramic radiographic image

	Protrusive interocclusal record		Panoramic radiographic image	
Patient	Right side	Left side	Right side	Left side
1	35	37	42	33
2	35	37	38	40
3	40	40	34	38
4	35	35	32	36
5	35	30	40	30
6	35	30	41	40
7	25	30	34	34
8	35	35	34	42
9	25	27	38	30
10	28	26	32	32
Mean	32.80	32.10	36.50	35.50
SD	5.01	5.9	3.75	4.35
p Value	0.596		0.625	

p-value < 0.05 significant.

Table 2 Difference between condylar guidance angles (in degrees) measured from protrusive interocclusal record (PIOR) and panoramic radiographic image on right and left sides

	PIOR (right)	Panoramic (right)	PIOR (left)	Panoramic (left)
Mean	32.80	36.50	32.10	35.50
SD	5.01	3.75	5.9	4.35
p Value	0.071		0.057	

p-value < 0.05 significant.

The inclination of the condylar path during protrusive movement can vary from steep to shallow in different patients. It forms an analog angle of 30.4° with the horizontal reference plane. The interocclusal records are used to set the condylar guides to approximate the anatomic limits of the temporomandibular joints. This allows the maximum benefit from using an articulator and facilitates in the fabrication of accurate restorations with a minimal time required for intraoral adjustment.[26]

Studies by Zamacona et al,[27] Lundeen and Wirth,[28] Woelfel et al,[29] Hobo and Mochizuki,[30] Preti et al,[31] and dos Santos et al[17] found variations in condylar guidance angles ranging from 5 to 55°. Looking at the variations in condylar guidance by the interocclusal record method, many clinicians use average condyle guide settings taken from mean published values.[32,33] Therefore, determining condylar guidance angle by panoramic radiographic image may be of value in programming the semi-adjustable articulator.

Conclusion

The study describes a simple method of recording protrusive condylar guidance angle by panoramic radiograph. The technique is easy to use, and the condylar guidance angles obtained by this method were not statistically significant when compared with the angles obtained by protrusive interocclusal record method. The records obtained by this method may be used to program the semi-adjustable articulator and obtain clinically acceptable restorations. Further studies should be carried out using different panoramic machines and also to determine the actual distortion of the panoramic radiograph.

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