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Comparison of Condylar Guidance Values Between Arcon and Non-Arcon Articulators at a Tertiary Care Hospital in Nepal

Munna Alam¹, Sarita Joshi², Sonam Chaudhary^{3,*}

¹ Nepalese Army Institute of Health Sciences, Bhandarkhal, Sanuvaryang, Kathmandu, Nepal

² National Academy of Medical Sciences, Mahankal Marg, Kathmandu, Nepal

³ Maharajgunj Medical Campus, Maharajgunj, Kathmandu, Nepal

Abstract

Introduction: The condylar guidance is the mandibular guidance that is originated by the condyle and articular disc, traversing the contour of the glenoid fossae. Its value is important during dental restorations. The present study compared the sagittal condylar guidance values between arcon and non-arcon articulators.

Methods: A cross-sectional study was carried out from January, 2013 to January, 2014 after receiving ethical approval from the institutional review board, National Academy of Medical Sciences, Kathmandu. A total of 16 volunteers, aged 19-35 years were enrolled. They had healthy dentition without any temporomandibular joint dysfunction. The same protrusive record with polysiloxane bite was used for sagittal condylar guidance values with Hanau H2 (non-arcon type) and Hanau Wide-View (arcon type) articulators. The values obtained from tracing of orthopantomogram was used as a standard to compare the resultant values for both articulators. The tabulated data were subjected to statistical analysis using SPSS version 16.0.

Results: The mean sagittal condylar guidance values of right side obtained by non-arcon articulator was $39.62^{\circ} \pm 4.01$, by arcon articulator was $36.75^{\circ} \pm 4.21$, and by panoramic tracing was $36.93^{\circ} \pm 4.41$. Similarly, the mean sagittal condylar guidance values of left side obtained by non-arcon articulator was $42.37^{\circ} \pm 4.36$, by arcon articulator was $38.93^{\circ} \pm 3.71$, and by panoramic tracing was $39.12^{\circ} \pm 3.82$. The mean comparison was statistically highly significant between arcon and non-arcon groups; and non-arcon and orthopantomogram tracing groups. However, no significant difference was observed between arcon and orthopantomogram groups.

Conclusion: Arcon articulators are more accurate in duplicating the sagittal condylar guidance values than non-arcon articulators, indicating that arcon articulators may be used in prosthesis fabrication for more accurate results.

Keywords: Arcon articulator, non-arcon articulator, orthopantomographic tracing, sagittal condylar guidance

1. Introduction

The success of complex prosthodontic procedures is enhanced by accurate simulation of the condylar path of a patient on an articulator. The mechanical form, located in the upper posterior region of an articulator that controls movement of its mobile member is called the

condylar guidance (CG)¹. The mandibular condylar path is the path travelled forward and downward by the condyles in the temporomandibular joints (TMJ) during various mandibular movements, and is peculiar to each individual^{2,3}. The angle at which the condyle moves away from a horizontal reference plane is called CG angle⁴. The CG angle recordings show variation between operators,

*Address for correspondence:

Dr. Sonam Chaudhary
Department of Clinical Physiology,
Maharajgunj Medical Campus,
P.O. Box 1524 (Dean's Office), Maharajgunj Sadak,
Kathmandu – 44600, Nepal
E-mail: sunamch@gmail.com

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between recording materials, and between articulators^{5,6}. The present study compared the sagittal CG values between arcon and non-arcon articulators with orthopantomographic (OPG) image readings.

2. Methods

A cross-sectional comparative study was carried out among 16 healthy volunteers at the Prosthodontics Unit, Department of Dental Surgery, National Academy of Medical Sciences, Bir Hospital, Kathmandu, Nepal, between January 2013 to January 2014 after getting the ethical clearance from Institutional Review Board (IRB). The sample size (n) was calculated with the mean and standard deviation values from the previous study⁷ with the sample size formula of $n = [(Z\alpha + Z\beta) S]^2/d^2$.

Inclusion criteria: (i) Male and female in the age range 19-35 years, (ii) angle's class I molar relationship with no spacing or crowding of anterior teeth and exhibiting an average degree of overjet and overbite, (iii) good neuromuscular function, and (iv) periodontally healthy and caries free teeth with no sign of alveolar bone loss or pathologic migration.

Exclusion criteria: (i) Congenital or acquired orofacial deformities, (ii) overjet and overbite more than 2-3 mm, (iii) history of previous craniofacial surgery/trauma and with restricted and deviated mouth opening, (iv) signs and symptoms of temporomandibular disorder, facial asymmetries and congenital facial defect, (v) prosthesis with minimum or no occlusal restorations, and (vi) pregnancy, xerostomia, skin reactions, and mucositis.

Two sets of alginate impressions (Zelgan 2002, Dentsply, India) were made for each subject and were poured immediately in Type III dental stone (Kalabhai Karson Pvt. Ltd., India) following the manufacturer's instructions and guidelines. Two sets of maxillary and mandibular casts were obtained for each individual. Face bow registration for both semi-adjustable articulator systems: Hanau H2 (non-arcon type) and Hanau Wide-Vue (arcon type) was accomplished as per the standard technique following user's instructions, using axis-orbitale as the reference plane and orbitale as the anterior point of reference. Both articulators were prepared (zeroing of articulators) by initial adjustment of 70° sagittal and 0° Bennett angles (Hanau H2) and 30° sagittal and Bennett angles (Hanau Wide-Vue). Horizontal and lateral incisal guidances were adjusted at 0° for both the articulators. Maxillary casts were secured in place in the compound index, assured for complete seating and mounted with fast setting plaster for both articulators. Upon complete setting of the mounting, the mounting guide and transfer rod with bite fork index assembly was removed carefully. Then the mandibular casts were articulated at maximal intercuspal position (MICP) via hand positioning. Similarly, the protrusive record was obtained in edge-to-edge relationship (6 mm)

after rehearsal of the position. Bite registration paste was extruded on the occlusal surfaces of the lower teeth and the subject was instructed to close his anterior teeth in edge-to-edge relationship. This protrusive record was then transferred to the articulators and the procedure for adjustment of sagittal CG value was repeated three times and the average of these values were taken on the right and left side for each participant.

Orthopantomography (OPG) is one of the commonly used diagnostic tools in dentistry. Anthropometric studies have shown the use of panoramic radiographs to measure CG, which can accurately represent the outline of articular eminence⁸. A single operator in the same location had taken the digital radiographs (Dental Imaging Center, Kathmandu, Nepal) with exposure factors of 68 kVp and 13 mA. The obtained images were saved using Planmeca Romexis® viewer program. 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 subjects. Two radio-opaque lines were consistently apparent on the panoramic radiographs in the region of the temporal bone. One depicted the outline of the articular eminence and fossa, and the second, the inferior border of the zygomatic arch. Each panoramic image was traced with Planmeca Romexis® viewer program with the help of an orthodontist and radio diagnostician. The sagittal outlines of the left and right articular eminences and glenoid fossae were traced. The left and right orbitale (lowest point in the margin of the orbit) and porion (highest point in the margin of the auditory meatus) were identified and the Frankfurt horizontal plane was constructed by joining the two landmarks on each side. The most superior point on the articular eminence and the most inferior point on the articular tubercle were identified and a second line to represent the mean condylar path inclination was constructed by joining the two points. The angle formed by the intersection of the two lines, the mean curvature line and the horizontal reference line was interpreted by using the software tool Planmeca Romexis® viewer program and was considered as panoramic radiographic sagittal CG value. The tracings were made three times and interpreted and the average of these three readings was considered as panoramic radiographic sagittal CG value. The data were entered and calculated using SPSS version 16.0 software. Student's paired t-test for group comparison and the confidence interval (CI) of 95% was considered as the level of significance.

3. Results

The age distribution of the 16 participants included 25% below the age of 20 years, 69% in the age group 20-29 years, and 6% above 30 years of age. The male:female ratio was 1:1.

The mean sagittal CG value among the participants was comparatively more by non-arcon articulator on both the right side (39.62°±4.01) and left side (42.37°±4.36) (Table 1).

Table 1: Mean sagittal condylar guidance values by different methods (n=16)

Sagittal condylar guidance value	Arcon articulator (mean±SD) (degrees)	Non-arcon articulator (mean±SD) (degrees)	Panoramic tracing (mean±SD) (degrees)
Right side	36.75±4.21	39.62±4.01	36.93±4.41
Left side	38.93±3.71	42.37±4.36	39.12±3.82

Comparison of the mean sagittal CG values between arcon vs non-arcon articulator (p=0.002) and non-arcon vs panoramic tracing (p=0.005) on the right side were highly significant. The result was

similar in the comparison of mean sagittal CG values on the left side. However, comparison of arcon vs panoramic on both sides were non-significant (p>0.05) (Table 2).

Table 2: Comparison of mean sagittal condylar guidance values by different methods (n=16)

Sagittal condylar guidance values	Parameters compared	Mean difference	p-value
Right side	Arcon vs non-arcon	-2.87	0.002*
	Arcon vs panoramic	-1.87	0.083
	Non-arcon vs panoramic	2.68	0.005*
Left side	Arcon vs non-arcon	-3.43	0.001*
	Arcon vs panoramic	-0.18	0.083
	Non-arcon vs panoramic	3.25	0.001*

Test conducted: paired t-test; *highly significant

4. Discussion

Dental restorations should be fabricated on an articulator that can accurately reproduce the mandibular movements in order to minimize the need for intraoral occlusal adjustments. Different semi-adjustable articulators are commonly used for the fabrication of occlusal surfaces of crowns, fixed partial dentures, implant protheses and conventional complete and removable partial dentures during diagnosis and treatment planning⁹. In this study, two articulators have been used, arcon and non-arcon, and the analysis of discrepancy between CG values obtained by these two articulators using protrusive records and CG values on orthopantomograms (OPG) were analysed.

While comparison was made between non-arcon and arcon articulators in the present study, the mean difference for sagittal condylar values was 2.87° and 3.43° on the right and left sides, respectively. This difference was statistically highly significant for both the right and left sides with lesser values for the arcon articulator. This difference might be due to the fact that condylar inclination changes in relation to maxillary occlusion in non-arcon articulators, as a certain degree of opening of the articulator takes place. However, in arcon articulators, the condylar inclination remains constant in relation to the maxillary occlusion plane at any degree of opening of the articulator. Studies have found that in the non-arcon design, condylar inclination of the mechanical fossae change in relation to the maxillary occlusion plane. This is because the articulator is opened and can lead to errors when a protrusive record of certain thickness is being used to program the articulator^{10,11}. These studies have reported that with 3-5 mm thickness of interocclusal record, there would be a difference of 8° between where the articulator settings are adjusted and a closed position where the articulator is used. These findings are in accordance with the present study. Thus, the average thickness of centric and protrusive interocclusal records must be within the range of 3-5 mm, depending on the type of interocclusal record material.

While comparing sagittal CG values obtained from arcon articulator and OPG readings, a mean difference of 1.87° and 0.18° was found on the right and left side respectively, which was statistically not significant. These findings correlate with the findings of another study¹², which studied the condylar movements and confirmed that in protrusion, the condylar head follows closely the anatomical form of the articular eminence and represents a very high correlation coefficient and level of significance. Another study found that a high degree of correlation existed between the protrusive condylar path and the steepness of the articular eminence. Also, the condylar path was slightly less steep than the steepness of the articular eminence, which may be attributed to the active role played by the soft tissues during condylar movements¹³. Another study reported a high degree of correlation between articular morphology and panoramic images. This suggested that the inclination of the articular eminence in a panoramic image may be of value in setting the CG in semi-adjustable articulators, which supports the present study¹⁴. The correlation between mean sagittal condylar readings of the arcon articulator and OPG readings could possibly be due to anatomic representation of the articular design in close approximation with the human TMJ. This anatomic duplication of the TMJ on the instrument may be responsible for near accurate replication of mandibular movements. However, a slight difference in values of both these groups could be justified by the active role played by the articular disc, ligaments, and muscles in condylar movements and neuromuscular synchronization during functional mandibular movements¹⁵.

Though this study has taken the radiographic method as a standard reference to compare the CG values with similar obtained from the arcon and non-arcon articulators, there are some limitations of the radiographic method as well. The orientation of head and reference plane, panoramic distortion, and difficulty to trace the articular

eminence outline from the zygomatic arch could be challenging¹⁶⁻¹⁸. These points can be considered in similar future studies with a larger sample size.

5. Conclusion

The sagittal CG values from non-arcon articulators showed greater discrepancy from the arcon articulators and panoramic tracings, indicating a low level of reproducibility. Thus, the sagittal CG values from the arcon articulators can be clinically utilized during dental restoration procedures.

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Conflict of Interest

SC is on the Editorial Board of the SAAP Journal of Integrative Physiology.

Authors' Contributions

MA conceptualized and designed the study. MA also contributed to data acquisition, literature search and acted as a guarantor. SJ was involved in study design and literature search. Additionally, SJ also reviewed and edited the manuscript. SC was involved in literature search, statistical analysis, and acted as guarantor. SC also contributed to preparation, review, and editing of the manuscript.

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