

Age Changes in Horizontal Condylar Angle: A Clinical and Cephalometric Study

T. Sreelal · Kavitha Janardanan · Amal S. Nair · Anjana S. Nair

Received: 28 June 2012 / Accepted: 9 October 2012 / Published online: 19 October 2012
© Indian Prosthodontic Society 2012

Abstract Determination of condylar inclination is important when restoring the occlusal surfaces of teeth. It is important to know the changing trends in horizontal condylar inclination with age so as to have an idea about the cuspal morphology. Aims and objectives: a) to determine the effect of age changes in horizontal condylar inclination using articulator method and radiographic method (cephalometry) b) to compare the values of horizontal condylar inclination obtained using articulator method with that of cephalometric method c) to ascertain the symmetry of horizontal condylar angle on both right and left side on an articulator. 40 dentulous individuals with Angle's class I occlusion were selected for the study. They were divided into four groups Group I: 20–29 years, Group II: 30–39 years, Group III: 40–49 years, Group IV: 50–59 years. Horizontal condylar inclination was determined on right and left side for each individual using protrusive interocclusal record in a Dentatus (ARL) semi-adjustable articulator. Cephalometric recording was carried

out twice on the left side, once in centric occlusion position and then in protrusive position. The two radiographs were superimposed to draw a line connecting the shifting position of condylion on an acetate tracing paper. This line when joined with Frankfurt horizontal plane gives the horizontal condylar inclination. Analysis of variance (ANOVA) revealed that there was a significant difference in horizontal condylar angle values in all the four groups which were statistically significant. There is a decrease in horizontal condylar angle values from Group I to Group IV. Horizontal condylar values obtained by articulator method and cephalometric method showed no significant difference for all the four groups tested. When horizontal condylar values obtained on right and left sides of Dentatus articulator were compared there was not much of a significant difference. Horizontal condylar values showed a decreasing trend with increasing age, i.e., as age advances there is a flattening of condylar head. Both articulator and cephalometric method yielded no significantly different values and hence both the methods can be used for determining condylar inclination. The difference in values of horizontal condylar angle on right and left sides were insignificant.

T. Sreelal · K. Janardanan
Department of Prosthodontics, Sree Mookambika Institute of Dental Sciences, Kulasekharam, Tamilnadu, India
e-mail: kavithajanardanan@yahoo.co.in

T. Sreelal (✉)
Sreesobha, IInd house, High school road, Kazhakuttom P.O., Trivandrum 695582, Kerala, India
e-mail: drsreelalt@gmail.com

A. S. Nair · A. S. Nair
Department of Orthodontics, Sree Mookambika Institute of Dental Sciences, Kulasekharam, Tamilnadu, India
e-mail: amalsnair@gmail.com

A. S. Nair
e-mail: anjanasreelal@gmail.com

Keywords Horizontal condylar angle · Dentatus articulator · Cephalometry

Introduction

The angle formed by the inclination of a condylar guide control surface of an articulator and a specified reference plane is the condylar guide inclination [1]. Radiographically, the angle formed in the horizontal plane between the Frankfurt horizontal plane and a line connecting a point on

the head of the condyle, in centric and protrusive position is referred to as the horizontal condylar angle. The determination of this angle is important when planning a restoration which alters the occlusal morphology of the teeth. Steepness of this angle determines the steepness of the cusps of the posterior teeth as well as the lingual inclines of the anterior teeth [2]. Age related changes in the condyle and glenoid fossa can affect the steepness of this angle which if not taken into consideration may result in unfavourable premature contacts during centric and eccentric jaw movements. This can be studied clinically by comparing the condylar inclination values obtained in an articulator for individuals with different age groups. A radiographic evaluation using lateral cephalogram provide an accurate morphology of condyle and anatomic structures to register the reference planes. Moreover the use of cephalometric methods for determining the effect of age changes in horizontal condylar inclination is not much documented.

Horizontal condylar inclination can be determined by various methods including interocclusal records [3], pantographic tracings [4], electronic jaw tracking devices [5], radiographic methods [6] etc. The protrusive interocclusal records are used on a semiadjustable articulator for setting horizontal condylar inclination after mounting the upper and lower casts with a centric interocclusal record. The angle determined on both right and left sides may be subjected to variation as a result of anatomical peculiarities. Hence a comparative evaluation of articulator method and cephalometric method for determination of condylar inclination seems to be logical in this context. Hence the present study was undertaken with the aim of determining the changes in horizontal condylar inclination values with age and to ascertain that these changes were symmetrical on both right and left sides. Another objective was to compare the values of horizontal condylar inclination obtained using articulator method with that of cephalometric method.

Methodology

Forty individuals with full complement of teeth with Angle's Class I relationship (with normal overjet and overbite) were chosen for the study. Individuals with any signs of temporomandibular dysfunction or periodontal disease were excluded. Only those individuals without a history of orthodontic treatment or fracture of mandible or maxilla were selected. The forty subjects were selected under four different age groups as follows: Group I, 20–29 years (I_1 – I_{10}); Group II, 30–39 years (II_1 – II_{10}); Group III, 40–49 years (III_1 – III_{10}); Group IV, 50–59 years (IV_1 – IV_{10}).

Maxillary cast was mounted on the Dentatus semiadjustable articulator (ARL, Hagersten, Sweden) following facebow transfer. Maxillomandibular relations were registered in centric occlusal and protrusive positions using Rock Occlufast (Zhermack, Italy) bite recording media. The protrusive jaw relation record was made to adjust the condylar elements of the articulator. The patient was asked to move the mandible 3–6 mm [7] straight forward and down from centric relation with the aid of a hand mirror. Patient was given practice to hold the teeth together in this protrusive position. Guide marks were placed on the anterior teeth. Moreover the correct straight protrusive record was ensured by the preparation of jig. A jig was prepared on one half side of the midline during the protrusive position with the help of clear self cure acrylic. After the preparation of the jig, bite registration media was injected over the posterior teeth and the patient was asked to protrude the mandible so that lower incisors would lock into the indentations of the jig.

After programming the dentatus articulator, the maxillary and mandibular casts were mounted using centric interocclusal record. For determining the condylar guidance the condylar locks of the articulator were loosened and the protrusive record was placed on the mandibular cast. The maxillary cast was seated into the indentations and the two parts were held firmly together and the condylar guidance on both sides of the articulator was read off. This step was repeated thrice to get at least two coincident readings. The condylar screws were tightened and the condylar readings on both sides were noted.

Two lateral cephalograms (Planmeca, Helsinki, Finland) were taken for each subject, one in centric position and one in protrusive position (with the jig in place). The two cephalograms were traced on a 36 μ thick tracing paper. The Frankfort horizontal plane was drawn from the superior outline of the porion to the orbitale. It is widely accepted as the horizontal plane of the head. The condylion point (most superior point on the head of the condyle) was marked in the cephalogram tracing of both centric (Fig. 1) and protrusive position (Fig. 2). The two condylion points were connected and projected to intersect the Frankfort horizontal plane. The angle thus formed constituted the actual condylar path angle. This evaluation was done only on the left side.

The horizontal condylar values obtained for the four age groups by both cephalographic and radiographic methods were subjected to one way Analysis of variance (ANOVA) to compare the changes in condylar angle with age and to find out whether any significant differences existed when condylar inclination was determined using the two methods described above. A comparative evaluation of the values obtained on right and left side on the Dentatus articulator was also carried out.

LEFT LATERAL CEPHALOMETRIC VIEW

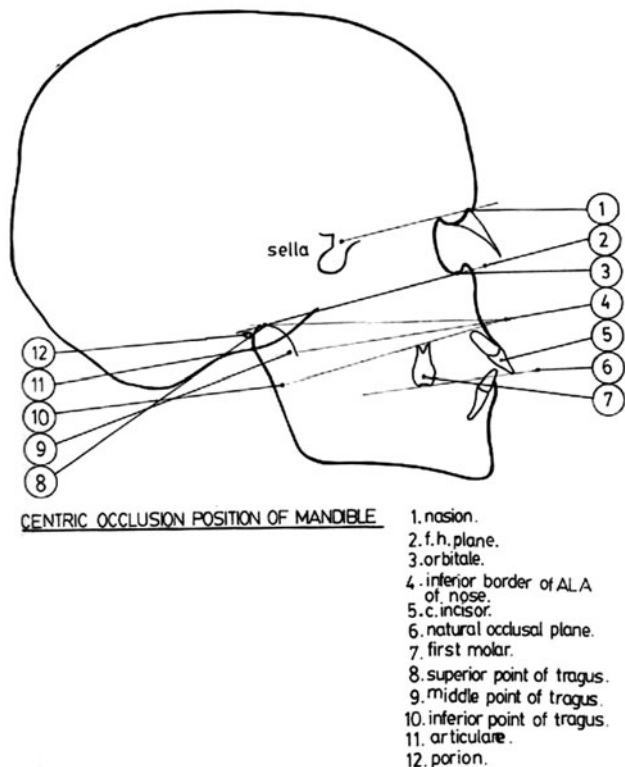


Fig. 1 Left lateral cephalometric view of centric occlusion position of mandible

OVER LAPPING VIEW OF CENTRIC OCCLUSION POSITION WITH PROTRUSIVE POSITION

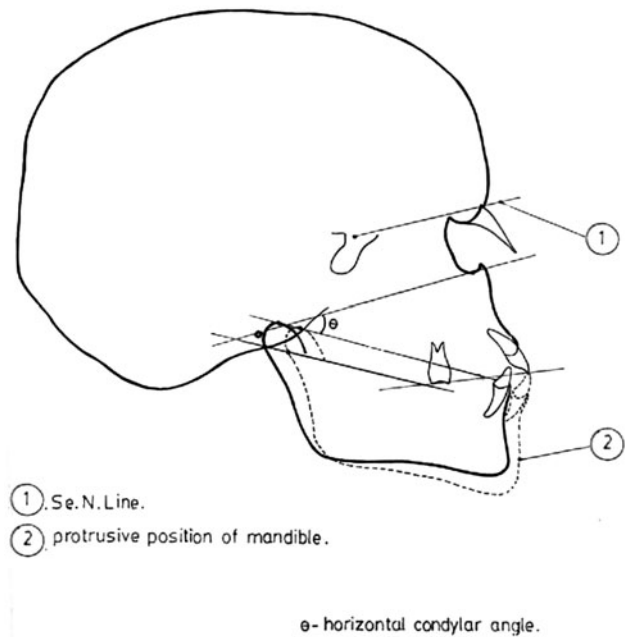


Fig. 2 Overlapping view of centric occlusion position with protrusive position. θ represents the horizontal condylar inclination

Results

The results of the study are detailed in Table 1. ANOVA (Table 1) was done to compare the differences in horizontal condylar angle with age determined by the two methods. ANOVA revealed that highly significant differences in horizontal condylar angle were observed among various age groups with both the methods. It can be observed from Table 2 that the degree of inclination decreases with age. But when the horizontal condylar angle values obtained with the two techniques on the left side for each group were compared (Table 1), it was observed that no statistically significant differences existed between them. The same result was noticed when a comparison was made between the left and right side values (vide Tables 3 and 4) on the dentatus articulator. No significant differences existed when both sides were compared for horizontal condylar inclination values.

Table 1 ANOVA to compare the differences in horizontal condylar angle obtained by articulator method and cephalometric method in different age groups on the left side

Source of variation	Degrees of freedom	Mean square	F
Between age groups (G)	3	3,608.85	115.23**
Between methods (M)	1	24.2	0.77 ^{ns}
G X M	3	89.93	2.87*
Error	72	31.32	
Total	79		

* Significant at 5 % level

** Significant at 1 % level

^{ns} Not significant

Table 2 Mean values of horizontal condylar angle (in degrees) of left side obtained by two methods

Group	Mean values of HCA in degrees by articulator method	Mean values of HCA in degrees by cephalometric method
Group I	59	54
Group II	44	44
Group III	34	39
Group IV	23	26
Mean	39.9	40.975
SE _m	1.77	
CD (.05)	5.01	

Table 3 ANOVA to compare the difference in horizontal condylar angle obtained on right and left sides on dentatus articulator

Source of variation	Degrees of freedom	Mean square	F
Between age groups (G)	3	3,654.48	37.66**
Between left versus right (S)	1	90.31	0.93 ^{ns}
G X S	3	89.93	0.93 ^{ns}
Error	72	97.05	
Total	79		

** Significant at 1 % level

^{ns} Not significant**Table 4** Mean values of horizontal condylar angle obtained between left and right sides on a Dentatus articulator

Group	Mean values of HCA in degrees by articulator method	Mean values of HCA in degrees by cephalometric method
Group I	51	54
Group II	42	44
Group III	36	39
Group IV	23	26
Mean	40	38
SE _m	3.12	
CD (.05)	6.23	

Discussion

The path followed by the condyle in the glenoid fossa is curvilinear. As the condyle moves out of the most superior and anterior position from glenoid fossa, it slides along the posterior slope of the articular eminence. The angle at which the condyle moves away from the horizontal reference plane is referred to as the condylar guidance angle. Hence the articulating surface of the condyle as well as the slope of the articular eminence influences the horizontal condylar angle obtained. Remodelling of the condyle occurs as a physiologic process to adapt to physical changes in the functioning teeth brought about by excessive wear. Flattening of the joint outlines, local erosion, local bony outgrowth (osteophyte), sclerosis, subcortical cyst (Ely's cyst) are a few of the changes that may be manifested in an aging condyle, of which flattening is the most commonly observed phenomenon [8]. These morphological variations were found to be more prevalent in individuals above 40 years of age [9, 10]. The decreasing values of horizontal condylar angle with advancing age in

the present study supports the claim. The mean horizontal condylar angles in Group I, II, III and IV showed a decreasing trend from younger to older age groups and these values were found to be statistically significant. This trend was noticed in both the articulator method as well as in the cephalometric method. The flattening of the condyle as well as the decrease in the posterior slope of the articular eminence results in decreased downward movement of the condyle in the glenoid fossa relative to the horizontal plane resulting in a decreased horizontal condylar angle.

The two techniques employed for determination of horizontal condylar angle, i.e., the articulator method and cephalometric method showed no statistically significant difference in values recorded on left side. Only the one side has been compared because the left and right condylar paths are considered to be the same [11]. But in general the articulator method resulted in lower values for horizontal condylar angles than cephalometric method for all age groups except Group I (20–29 years) which may be due to the greater amount of posterior disocclusion during protrusion. With a dentatus ARL articulator, the thickness of the interocclusal bite registration can affect the horizontal condylar angle values, because the condylar inclination changes in accordance with maxillary occlusal plane [12]. This finding correlates with the results obtained by Goyal et al. [13] who compared the discrepancy in condylar guidance values between an arcon and a non-arcon articulator against the cephalometric readings in the age group of 20–35 years. Pavankumar et al. [6] compared the interocclusal record and panoramic radiographic method for determining horizontal condylar angle and found that the readings obtained with both methods were not statistically significant although panoramic method yielded values that were on an average 4° higher. Similar results were also observed in studies conducted by Nandini et al. [14] who found the differences in condylar inclination obtained from articulator method and cephalometric method being insignificant.

Horizontal condylar inclinations on both right and left sides may vary as a result of anatomical variations and habitual patterns. But the variability in the present study was between 0.5–3° for all age groups, which is well within the standard accepted value. Difference of <5° between right and left condylar inclination have been described as normal [15, 16]. Condylar recordings of both left and right sides using jaw tracking devices [5] and panoramic radiographs [6] have proved that the differences in values were insignificant. Also the difference in values between right and left side showed a decreasing trend with advancing age. Hence it can be assumed that remodelling changes in condyle can smoothen out the variability in horizontal condylar values on both sides.

Conclusion

The following inferences can be drawn from the study:

- a) There is a significant difference in horizontal condylar angle in the four age groups studied. As age increases the horizontal condylar angle decreases.
- b) The horizontal condylar angle determined using articulator method and cephalometric method did not show any significant differences. Any of these methods can be used for determination of horizontal condylar angle.
- c) The differences in horizontal condylar angle determined on the right and left side with the articulator method was not statistically significant.

References

1. The Glossary of Prosthodontic terms, 8th edn (2005) Academy of Prosthodontics. *J Prosthet Dent* 94(1):10–92
2. Jose dos Santos Jr (1999) *Occlusion Principles and Concepts* 2nd edn. Ishiyaku Euro America, Inc. U.S.A 45
3. Ratzmann A, Mundt T, Schwahn C, Langforth G, Hutzen D, Gedrange T, Kordass B (2007) Comparative clinical investigation of horizontal condylar inclination using the JMA electronic recording system and a protrusive wax record for setting articulators. *Int J Comput Dent* 10(3):265–284
4. Curtis DA (1989) A comparison of protrusive records to pantographic tracings. *J Prosthet Dent* 62:154–156
5. Hernandez AI, Jasinevicius TR, Kaleinikova Z, Sadan A (2010) Symmetry of horizontal and sagittal condylar path angles: an in vivo study. *Cranio* 28(1):60–66
6. Tannamala PK, Pulagam M, Pottam SR, Swapna B (2012) Condylar Guidance: Correlation between Protrusive Interocclusal Record and Panoramic Radiographic Image: A Pilot Study. *J Prostho* 21(3):181–184
7. Zarb GA, Bolender CL (2004) *Prosthodontic treatment for edentulous patients: Complete dentures and implant-supported prosthesis*, 12th edn. Mosby, St Louis, p 294
8. Takayama Y, Miura E, Yuasa M, Kobayashi K, Hosoi T (2008) Comparison of occlusal condition and prevalence of bone change in the condyle of patients with and without temporomandibular disorders. *Oral Surg Oral Med Oral Pathol Oral Radiol Endodontology* 105(1):104–112
9. Muir CB, Goss AN (1990) The radiologic morphology of asymptomatic temporomandibular joints. *Oral Surg Oral Med Oral Pathol* 70(3):349–354
10. Mathew AL, Sholapurkar AA, Pai KM (2011) Condylar Changes and Its Association with Age, TMD, and Dentition Status: A Cross-Sectional Study. *Int J Dent* 2011:1–7
11. Cohen R (1956) The relationship of anterior guidance to condylar guidance in mandibular movement. *J Prosthet Dent* 6:758–767
12. Shillingburg T, Herbert T, Hobo S, Whitsett LD, Jacobi R, Brackett SE (1997) *Fundamentals of fixed prosthodontics*, 3rd edn. Quintessence Publishing Co, Illinois, pp 42–81
13. Goyal MK, Goyal S (2011) A comparative study to evaluate the discrepancy in condylar guidance values between two commercially available arcon and non-arcon articulators: a clinical study. *Indian J Dent Res* 22(6):880
14. Nandini VV, Nair KC, Sudhakar MC, Poduval TS (2005) Comparative evaluation of hight tracer, Chandra tracer, intraoral tracer, functiograph and checkbite: a clinical study. *J Indian Prosthodont Society* 5(5):26–32
15. Caro AG, Peraire M, Martinez-Gomis J, Anglada JM, Samsó J (2005) Reproducibility of lateral excursive tooth contact in a semi-adjustable articulator depending on the type of lateral guidance. *J Oral Rehabil* 32:174–179
16. Ash MM, Ramfjord S (1995) Occlusion in operative and restorative dentistry. In: Ash MM, Ramfjord S (eds) *Occlusion*, 4th edn. W.B. Saunders Co., Philadelphia, pp 422–423