Section: Dentistry

Buccolingual Inclination of Maxillary and Mandibular First Molars in Untreated Adults: A CBCT Study

Mohamad Aslam Baidar Gull[1], Mudasir Yaqoob[2], Mohammad Mushtaq[3], Samirah Maqbool[4]

ABSTRACT

Introduction: The general feature of occlusal curvature, when viewed from the front, consists of a buccal inclination of the maxillary molars and a lingual inclination of the mandibular molars. The fourth key of Andrews six keys of occlusion is related to the curve of Wilson, describing the posterior inclination of the crowns of the lower posterior teeth as a concave curve, setting the molars with a lingual torque. The aim of this study was to measure buccolingual inclination of maxillary and mandibular first molars in untreated sample of pre-orthodontic patients.

Material and Methods: CBCT scans from 36 untreated subjects (26 females and 10 males; average age, 24.6 years) with minimal dental discrepancies, no prior history of orthodontic treatment, minimal dental wear, no posterior crossbite, no crowns or significant restorations on any first molars, absence of remaining primary dentition, were selected. The angles were measured between long axis of each maxillary molar to a vertical reference line that was perpendicular to the horizontal reference line and between each mandibular first molar to the same reference line.

Results: The average inclination of maxillary molar was +4.98º ± 4.26º. There was no significant difference between the right and left mean values. The average inclination of mandibular molar was -13.10º ± 6.10º. There was no significant difference between the right and left values.

Conclusion: Maxillary and mandibular molars have a natural curvature of their inclinations where the maxillary molars have a slight buccal inclination and mandibular molars have a slight lingual inclination.

Keywords: Buccolingual Inclination, CBCT, Compensatory Curve, Occlusal Plane

INTRODUCTION

Occlusal plane lies on a curve on which, when viewed from the front, the maxillary posterior occlusal surfaces comprise the convex part of the curve and the mandibular posterior occlusal surfaces are the concave part of the curve.[1] In 1911, George H. Wilson described this phenomenon with a curve, as a compensatory curve to avoid possible balancing interferences. Therefore palatal and buccal cusps of posterior teeth contact in a functional way. The occlusal curvature has been described as having a progressive increase in molar axial inclination from first molar to third molar.[2,3] The general feature of the curvature consists of a buccal inclination of the maxillary molars and a lingual inclination of the mandibular molars.

Analyzing a sample of 120 normal occlusion cases with optimal tooth alignment and occlusion, Andrews[4] described six keys of occlusion to develop the Straight Wire Appliance, conforming a practical finishing occlusal guide. The fourth key is related to the curve of Wilson, describing the posterior inclination of the crowns of the lower posterior teeth as a concave curve, setting the molars with a lingual torque. However, the specific amount of curvature had not been quantified.

The American Board of Orthodontics (ABO) states that "in order to establish proper occlusion in maximum intercuspation and avoid balancing interferences, there should not be a significant difference between heights of the buccal and lingual cusps of the maxillary and mandibular molars and pre-molars".[5] Age-related changes in the buccolingual inclinations of molars and their link to intermolar arch-width changes have been investigated previously. It was reported that both maxillary and mandibular molars upright with age while intermolar widths increase.[6,7] Wilson`s curve has been the subject of studies related to the change in angulation of molars during growth, as an indicator of post-expansion maxillary stability and also as an etiological factor in temporomandibular disorders.[8,9,10] Alqerban et al. reported the applicability of the cone-beam computed tomography in the position, inclination of the teeth, and its relation to adjacent structures.[11] Measurement of the mesiodistal angulation and the faciolingual inclination of the whole tooth requires 3-dimensional images of the roots; these have become available only recently. The volumetric images obtained from cone-beam computed tomography (CBCT) scans show the dentofacial structures in a 1:1 ratio, and distortions, if any, are clinically insignificant.[12]

The aim of this study was to develop a reliable method to measure buccolingual inclination of maxillary and mandibular

L10

International Journal of Contemporary Medical Research
Volume 6 | Issue 12 | December 2019 | ICV: 98.46 |
ISSN (Online): 2393-915X; (Print): 2454-7379

first molars in untreated sample of pre-orthodontic patients.

MATERIAL AND METHODS

The study was carried out on the records present in the Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College & Hospital, Shireen Bagh, Srinagar. CBCT scans were taken for orthodontic reasons. A study sample of 36 subjects was selected. In selecting the subjects, the inclusion criteria were; adults having full complement of teeth with minimal dental discrepancies, no prior history of orthodontic treatment, minimal dental wear. The exclusion criteria were; posterior crossbite, crowns or significant restorations on any first molars, presence of remaining primary dentition, extensive dental restorations or wear, and craniofacial deformities.

All CBCT scans were obtained using NewTom GiANO NNT Scanner. All the scans were taken using the same machine by the same operator. The scanning parameters of CBCT scans were: X-ray source of HF with constant potential (DC), 90kV, 3mA (pulsed); focal spot 0.5mm, dose 80-100 µSv, FOV 11cm×11cm, and scan time 9 seconds.

All the selected CBCT scans were analyzed by the software provided by the manufacturer. Each scan was standardized and oriented in such a way that the Frankfort horizontal plane and a line connecting the inferior border of the orbital rims were parallel to the ground. As per Masumoto's guideline, the sagittal guideline of the tooth axis was defined as a line passing through the midpoint of the mesiodistal crown width and the midpoint between both middle points of each of the mesial and distal roots at one-third the distance from the apex.[7] The coronal cross-section was obtained using a section that best fitted the right and left molar mesiodistal midpoints. The coronal section was used to measure the tooth axes. The long axis of the tooth was defined as a line connecting the midpoint of the buccal and lingual cusp tips and the midpoint of the buccolingual width at the cervical base of the anatomic crown (Figures A and B). Then the angles were measured between long axis of each maxillary molar to a vertical reference line that was perpendicular to the horizontal reference line and between each mandibular first molar to the same reference line. If the crown was buccal to the roots, the inclination was considered as positive (+) and if it was lingual to the roots, the inclination was considered as negative (-).

CBCT scans from 36 untreated subjects were selected according to the criteria and then analyzed. The sample included scans of 10 male and 26 female subjects.

The intraexaminer reliability was determined by the principal investigator by reviewing ten randomly selected CBCT scans twice at an interval of 1 month. A paired t-test was used to determine whether there were significant differences from the original measurements. A P-value of less than 0.05 was considered statistically significant. The statistical analysis of data was carried by applying descriptive statistics viz. mean, range and standard deviation.

RESULTS

All measurements showed intraclass correlation values >0.94, showing excellent reproducibility. Of the 36 subjects in the study, 26 were female and 10 were male, with an overall average age of 24.6 years (range, 13-40 years; SD, 6.8 years).

Table 1 shows the values for the maxillary first molar inclinations. The average inclination of maxillary right first molar was +5.12º (range, -4.8º to +14.6º; SD, ± 4.20º) and average inclination for maxillary left first molar was +4.84º (range, -5.2º to +14.4º; SD, ± 4.28º). The average inclination of maxillary molar was +4.98º ± 4.26º. There was no significant difference between the right and left mean values.
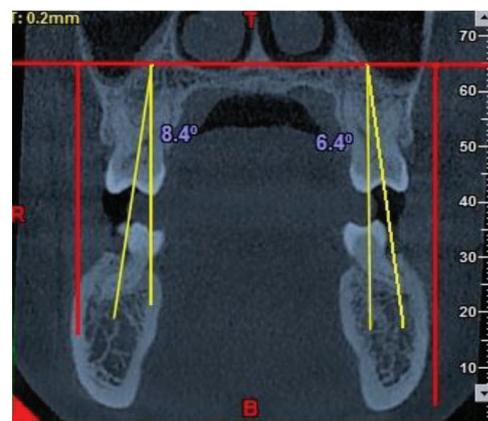

Figure-A: Coronal view of CBCT scan showing angular measurements of maxillary first molars.
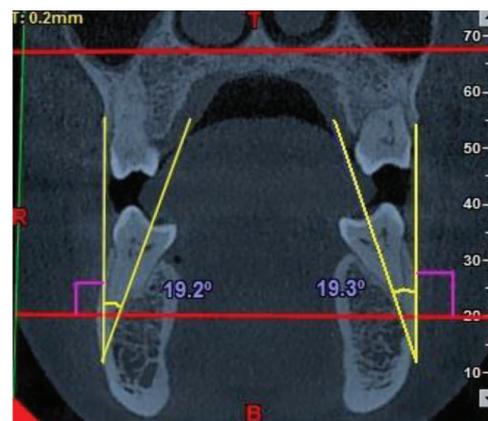
Figure-B: Coronal view of CBCT scan showing angular measurements of mandibular first molars

Tooth	n	Minimum inclination	Maximum inclination	Mean value	SD
Maxillary right first molar	36	-4.8º	+14.6º	+5.12º	4.20
Maxillary left first molar	36	-5.2º	+14.4º	+4.84º	4.28
Average, maxillary first molars	72	-4.8º	+14.6º	+4.98º	4.26
Table-1: Inclination of Maxillary First Molars					

Section: Dentistry

Gull, et al.   Buccolingual Inclination of Maxillary and Mandibular First Molars in Untreated Adults

Tooth	n	Minimum inclination	Maximum inclination	Mean value	SD
Mandibular right first molar	36	-27.4º	+2.6º	-13.42º	6.22
Mandibular left first molar	36	-28.2º	+1.2º	-12.78º	6.04
Average, mandibular first molars	72	-28.2º	+2.6º	-13.10º	6.10

Table-2: Inclination of Mandibular First Molars

Table 2 shows the values for inclination of mandibular first molars. The average inclination of mandibular right first molar was -13.42º (range, -27.4º to +2.6º; SD, ± 6.22º) and average inclination for mandibular left first molar was -12.78º (range, -28.2º to +1.2º; SD, ± 6.04º). The average inclination of mandibular molar was -13.10º ± 6.10º. There was no significant difference between the right and left values.

DISCUSSION

The buccolingual inclination of incisors has been studied extensively by using lateral cephalograms, which allow convenient visualization of the long axis of the incisor tooth and its relationship to the skeletal base. There have also been many reports on the relationship between lower incisor and mandibular symphysis evaluated on lateral cephalograms. The mesiodistal changes of the mandibular molar axis during treatment have also been evaluated by lateral cephalometry.[13] However, CT scans are required to visualize the long axis of posterior teeth.[14] One of the advantages of using CBCT is the ability to visualize the tooth along with its root, thus removing the uncertainty in determining the long-axis of a tooth that can result from using casts with uneven cusp wear or crown and root morphology.[15] Because the maxillary molar roots are frequently divergent, determining the tooth axis for the maxillary molars poses specific challenges. Shewinvanakitkul et al.[3] measured the long axis of the mandibular first molars using a line from the central groove to the middle of the apices. Barrera et al.[16] used a line connecting the central groove to the furcation for the molar axis, which is similar to the method used in this study. The results of this study are consistent with previous reports of presence of a buccolingual curvature of molars in untreated dentitions.[1,2,17–19] The findings suggest that mandibular first molars in untreated adults have a mean lingual inclination of 13.1º; however, there is limited literature reporting values for this inclination. Ross et al. reported a mean mandibular molar lingual inclination of 7.1º ± 4.6º, but the study was performed on casts.[20] Shewinvanakitkul et al.[3] found a lingual inclination of 15.4º ± 4.7º in mandibular first molars in untreated Class I patients; however, their subjects had a mean age of only 13.2 years. Based on previous studies, there is a change in axial inclination of molars with growth, so studies including growing patients may not yield reliable values. Marshall et al.[8] also reported a mandibular first molar lingual inclination of 2.08º ± 4.80º for the mesiolingual cusp of the left first molar at age 26.4 and 4.53º ± 5.86º for the distolingual cusp of the right first molar at age 26.4 using dental casts.

In our study the mean buccal inclination of maxillary first molars was 4.98º per side. Tong et al.[15] reported mean buccal inclination of 4.73º for the maxillary first molars with their volumetric measurements. The Barrera et al.[16] reported 4.05º of crown torque for each side, but their sample size was only 10 subjects while as Ross et al.[15] reported a mean buccal inclination of 8.0º ± 4.0º in the maxillary first molars in a group of subjects aged between 9.5 years and 41.5 years and using casts.

There are two reasons for the existence of the curve of Wilson according to Dawson.[21] One is for optimal resistance to loading, whereby the buccolingual inclination of the posterior teeth parallels the inward pull and orientation of the internal pterygoid muscle contraction to produce the greatest resistance to masticatory forces. The other reason is that the inward inclination of the occlusal table allows open access to food as it is being chewed, facilitating the masticatory process. Nanda[22] stated that a small curve of Wilson between the buccal segments allows for proper occlusal function, but an accentuated curve will result in balancing interferences. According to Okeson,[23] the occlusal curvature exists to have the most effective use of cuspal contacts, while avoiding nonfunctional contacts known as balancing interferences. It is important to find out what an appropriate amount of buccolingual tooth inclination is for adequate function, and to quantify it so that we can have treatment goals that are well-supported by evidence. In the six-element philosophy, Andrews[24] explained, that ''each crown must be inclined so that the occlusal surface can interface and function optimally with the teeth in the opposing arch.'' McNamara[25] suggested that one of the goals of orthodontic treatment should be to flatten the occlusal plane and level the curve of Wilson. In contrary to this, Dawson[21] stated that on flattening the curve of Wilson too much, ease of masticatory function may be impaired. The ABO suggests that either maxillary buccal cusps or mandibular lingual cusps be no more than 1 mm off the surface of a straight edge. It would therefore be logical to consider maintaining some degree of a curve of Wilson after orthodontic treatment, to be consistent with the physiologic needs of masticatory function. Our findings support the natural presence of a mild curve of Wilson in untreated adults. Further studies are warranted to investigate normal values for buccolingual inclination of the entire posterior dentition.

CONCLUSION

The average buccal inclination of maxillary molars in untreated adults is +5.12º ± 4.20º. Mandibular first molars in untreated adults had an average lingual inclination of -13.42º ± 6.22º. Mandibular molars are naturally less upright than maxillary molars.

REFERENCES

1. Ackerman F. The helicoid principle in human dental occlusion. Int Dent J 1963; 13:532.
2. Andrews LF. Straight Wire: The Concept and the Appliance. San Diego: L.A. Wells; 1989.
3. Shewinvanakitkul W, Hans MG, Narendran S, Martin Palomo J. Measuring buccolingual inclination of mandibular canines and first molars using CBCT. Orthod Craniofac Res. 2011; 14:168–174.
4. Andrews F.L. The six Keys to normal Occlusion. Am J Orthod. 1972; 62:296-309.
5. Casko JS, Vaden JL, Kokich VG, et al. Objective grading system for dental casts and panoramic radiographs. American Board of Orthodontics. Am J Orthod Dentofacial Orthop. 1998; 114:589–599.
6. Mitra S, Ravi MS. Evaluation of buccolingual inclination of posterior teeth in different facial patterns using computed tomography. Ind J Dent Res. 2011; 22:376–380.
7. Masumoto T, Hayashi I, Kawamura A, Tanaka K, Kasai K. Relationships among facial type, buccolingual molar inclination, and cortical bone thickness of the mandible. Eur J Orthod. 2001; 23:15–23.
8. Marshall S, Dawson D, Southard KA, Lee AN, Casko JS, Southard TE. Transverse molar movements during growth. Am J Orthod Dentofacial Orthop. 2003; 124:615-24.
9. Handelman CS, Wang L, BeGole EA, Haas AJ Haas. Non surgical Rapid Maxillary Expansion in Adults Reporto on 47 Cases using the Haas Expander. Angle Orthod. 2000; 70:129-44.
10. Ito H, Okimoto K, Mizumori T, Terada Y, Maruyama T. A clinical study of the Relationship Between Occlusal Curvature and Craniomandibular Disorders. Int J Prosthodont. 1997; 10:78-82.
11. Alqerban A, Jacobs R, Lambrechts P, Loozen G, Willems G. Root resorption of the maxillary lateral incisors caused by impacted canine: a literatura review. Clin Oral Investig. 2009; 13:247-55.
12. Lascala CA. Analysis of the accuracy of linear measurements obtained by cone beam computed tomography (CBCT-NewTom). Dentomaxillofac Radiol 2004;33:291-4.
13. Rebellato J, Lindauer S J, Rubenstein L K, Isaacson R J, Davidovitch M, Vroom K. Lower arch perimeter preservation using the lingual arch. Am J Orthod Dentofacial Orthop. 1997; 112: 449-456.
14. Tsunori M, Mashita M, Kasai K. Relationship between facial types and tooth and bone characteristics of the mandible obtained by CT scanning. Angle Orthod 1998;68:557-62.
15. Tong H, Kwon D, Shi J, Sakai N, Enciso R, Sameshima GT. Mesiodistal angulation and faciolingual inclination of each whole tooth in 3-dimensional space in patients with near normal occlusion. Am J Orthod Dentofacial Orthop. 2012; 141:604–617.
16. Barrera JM, Llamas JM, Espinar E, Sa´enz Ram´ırez C, Paredes V, P´erez-Varela JC. Wilson maxillary curve analyzed by CBCT. A study on normocclusion and malocclusion individuals. Med Oral Patol Oral Cir Bucal. 2013; 18:547–552.
17. Bonwill WGA. Geometrical and mechanical laws of articulation. Trans Odontol Soc Pa. 1885:119–133.
18. Monson GS. Applied mechanics to the theory of mandibular movements. Dent Cosmos. 1932; 74: 1039–1053.
19. Smith BH. Development and evolution of the helicoidal plane of dental occlusion. Am J Phys Anthropol. 1986; 69:21–35.
20. Ross VA, Isaacson RJ, Germane N, Rubenstein LK Influence of vertical growth pattern on faciolingual inclination and treatment mechanics. Am J Orthod Dentofacia Orthop. 1990; 98:422–429.
21. Dawson PE. Functional Occlusion: From TMJ to Smile Design. St. Louis: Mosby; 2007.
22. Nanda R. Biomechanics and Esthetic Strategies in Clinical Orthodontics. St. Louis: Elsevier Saunders; 2005.
23. Okeson JP. Management of Temporomandibular Disorders and Occlusion. 7th ed. St. Louis: Elsevier; 2012.
24. Andrews LF. Andrews WA. The six elements of orofacial harmony. Andrews J Orthod Orofacial Harmony. 2000;1:13–22.
25. McNamara JA, Brudon WL, Kokich VG. Orthodontics and Dentofacial Orthopedics. Ann Arbor, Mich: Needham; 2001.

Section: Dentistry