Open Journal of Stomatology, 2019, 9, 64-74
http://www.scirp.org/journal/ojst
ISSN Online: 2160-8717
ISSN Print: 2160-8709

Mesially Directed Inclination of Posterior Teeth Contributing to Maxillary High Canine, and Changes during Orthodontic Treatment

Morio Masunaga[1], Hiroshi Ueda[2*], Tatsuya Shibaguchi[1], Kazuo Tanne[2]

[1]Masunaga Orthodontic Office, Osaka, Japan
[2]Department of Orthodontics and Craniofacial Developmental Biology, Graduate School of Biomedical Sciences, Hiroshima University, Hiroshima, Japan
Email: *milm@hiroshima-u.ac.jp

How to cite this paper: Masunaga, M., Ueda, H., Shibaguchi, T. and Tanne, K. (2019) Mesially Directed Inclination of Posterior Teeth Contributing to Maxillary High Canine, and Changes during Orthodontic Treatment. *Open Journal of Stomatology*, **9**, 64-74.
https://doi.org/10.4236/ojst.2019.93007

Received: February 14, 2019
Accepted: March 11, 2019
Published: March 14, 2019

Abstract

Objective: The aim of study was to evaluate the nature of mesiodistal angulation of the posterior teeth in patients with maxillary high canine, and to identify possible associations of crowding with mesial axial angulation of the maxillary posterior teeth. **Methods:** The present study included seven Japanese male and 23 Japanese female patients. Study models were analyzed to evaluate the effectiveness of orthodontic treatment. A protractor was used to measure crown angulations, which were measured with reference to the posterior angle between the functional occlusal plane (FOP) and the long axis of the clinical crown of the lateral teeth and first molars. A sliding digital caliper was used to measure dental arch widths. Changes in the rotation of the maxillary molars were analyzed using "occlusograms", which were printed from photographs of the occlusal aspect of the study model. **Results:** The maxillary teeth interacted with one another in the alveolar bone, resulting in progressive mesial tipping of the posterior teeth before orthodontic treatment. After orthodontic treatment, the angle relative to the FOP exhibited a significant increase, indicating that the maxillary teeth underwent distally directed uprighting ($P < 0.05$). The upper and lower dentitions exhibited a considerable increase in dental arch width after treatment ($P < 0.01$). Meanwhile, the rotation of the posterior teeth did not exhibit any significant changes. **Conclusions:** Based on the results, both uprighting of mesially tipped lateral teeth and expansion of narrow dental arches could prove to be keys to success in space regaining or correction of high canines and mild crowding.

Keywords

High Canine, Posterior Teeth, Crown Angulation, Functional Occlusal Plane

1. Introduction

Crowding is a malocclusion with irregularly positioned teeth caused by arch length discrepancy (ALD); clinically, its incidence is comparatively high among various types of malocclusions [1] [2] [3] [4]. In general, the maxillary and mandibular dentitions exhibit different patterns of crowding [5], even if tooth-jaw discrepancy is an essential cause of crowding in both dentitions. Maxillary high canine and malposition of the mandibular incisors is a typical example. Maxillary high canine and slight malposition of the mandibular incisors may involve completely different mechanisms; the cause of this malocclusion, however, has not been fully elucidated. In a previous study exploring this mechanism [6], it was demonstrated that the crowns of the maxillary posterior teeth erupt mesially in relation to the functional occlusal plane (FOP) in cases involving Angle's Class I with high canines, and were uprighted by non-extraction orthodontic treatment. The prominent mesial axial angulation of the maxillary posterior teeth relative to the FOP was regarded to be an essential factor in the onset of the above-mentioned crowding. However, the results were based only on two cases evaluated using plaster models.

The aim of present study, therefore, was to evaluate the nature of mesiodistal angulation of the posterior teeth in patients with maxillary high canine, and to identify possible associations of crowding with mesial axial angulation of the maxillary posterior teeth—widely regarded to be the principal cause of crowding—using 30 case models for non-extraction orthodontic treatment.

2. Methods

2.1. Subjects

The present study included seven Japanese male (mean [±SD] age 12.4 ± 1.4 years) and 23 Japanese female (mean age 11.7 ± 1.6 years) patients at Masunaga Orthodontic Office between 2006 and 2012. The inclusion criteria were as follows: (patients with) normal horizontal and vertical skeletal relationships; Angle's Class I malocclusion; maxillary high canine and mandibular ALD < 1 mm; treatment using multibracket appliances without premolar extraction; and normal mesiodistal crown size. The exclusion criteria were as follows: (patients with) missing the permanent teeth; severe skeletal discrepancies; abnormal mesiodistal crown size; and complications from serious systemic disease. Each subject provided informed written consent to participate in the study. The institutional ethics committee approved the study design, which adhered to the tenets of the amended Declaration of Helsinki.

2.2. Measurement of ALD

The distance between the anatomical contact points of the adjacent two teeth was measured on pre- and post-treatment study models using a 1/20 mm caliper (Mitsutoyo Co. Ltd., Kawasaki, Japan). Crowding was measured as the discrepancy between the sum of the anatomical mesiodistal space between the teeth before and after treatment. Crowding was localized to the anterior teeth, and the absence of crowding was confirmed in the molars. All measurements were performed and recorded by one of the authors (MM). The mean (± SD) ALD was −3.6 ± 2.4 mm in the maxilla and less than 1 mm in the mandible, respectively.

2.3. Measurements of Crown Angulation

Study models were analyzed to evaluate the effectiveness of orthodontic treatment. The upper and lower bases of the study models were trimmed with sliding parallel plates to make them parallel to the functional occlusal plane. A protractor with an adjustable readout arm (Shinwa Co. Ltd., Sanjyo, Japan) was used to measure crown angulations (**Figure 1**), which were measured [6] with reference to the posterior angle between the FOP and the long axis of the clinical crown of the lateral teeth and first molars (**Figure 2**). The measurements read on the protractor's scale were evaluated to quantify crown angulations in the upper and lower dentitions.

2.4. Measurement of Dental Arch Widths

A sliding digital caliper (Mitsutoyo Co. Ltd., Kawasaki, Japan), with a precision of ±0.02 mm, was used to measure dental arch widths. All measurements were performed and recorded by one of the authors (MM). The reference points and landmarks are shown in **Figure 3**. The inter-molar, inter-premolar, and inter-canine widths were measured to quantify changes in the upper and lower dental arches.

2.5. Measurement of the Rotation of the Posterior Teeth

Changes in the rotation of the maxillary molars were analyzed using "occlusograms" [7], which were printed from photographs of the occlusal aspect of the

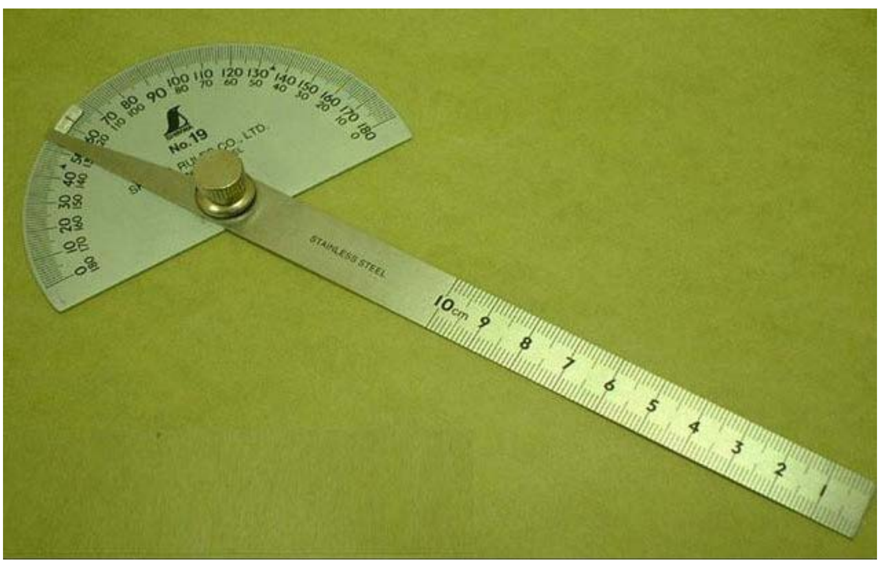

Figure 1. A protractor with an adjustable readout arm.

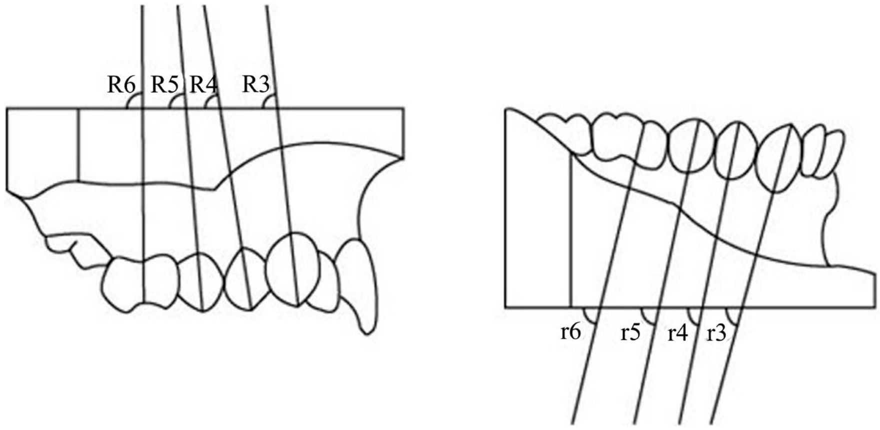

Figure 2. Crown angulation measurements.

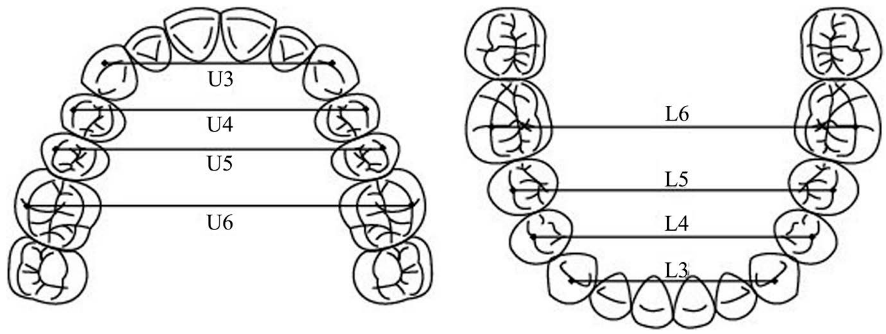

Figure 3. A schematic illustration for the measurement of dental arch widths: inter-molar width; the distance between the buccal groove at the buccal and occlusal surface interface of the bilateral first molars (maxilla: U6, mandible: L6), inter-premolar width (maxillary first and second premolars: U4 and U5, mandibular first and second premolars: L4 and L5); the distance between the buccal cusps of the bilateral premolars, inter-canine width; the distance between the buccal cusps of the bilateral canines (maxilla: U3, mandible: L3).

study model, taken at the same magnification using a digital camera mounted in affixed position [8] [9]. Each occlusogram was traced on acetate paper to describe the maxillary molars with the buccal cusp ridges, central grooves and cusp tips, and the palatal rugae and the midpalatal raphe. The palatal midline was constructed by connecting the midpoints of the incisive papilla, the midpalatal raphe, and fovea palatinus. The posterior angles formed by the palatal midline, and the line through the buccal and lingual cusps on each premolar, and through the distobuccal and mesiolingual cusps on each first molar were measured (**Figure 4**). Changes in the angle of rotation relative to the palatal midline before and after treatment were compared in each patient.

2.6. Statistical Analysis

Measurement error was determined using duplicate measurements of all variables during a one-month interval. A paired *t* test was used to compare intraobserver differences; a two-tailed *P*-value < 0.05 was considered to be statistically significant. The paired *t* test was also used to compare measurements before and after

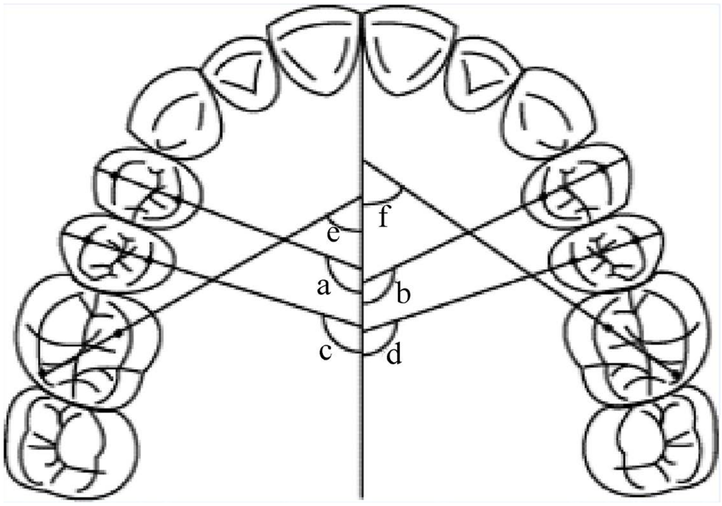

Figure 4. A schematic illustration for the measurement of the rotation of maxillary posterior teeth. The angle of rotation relative to the palatal midline; (a) right first premolar, (b) left first premolar, (c) right second premolar, (d) left second premolar, (e) right first molar, (f) left first molar.

treatment. The mean changes in axial angulations were compared using repeated-measures analysis of variance (ANOVA) followed by Scheffe's test.

3. Results

Intraobserver variation in the measurements was considered to be negligible because this value did not differ significantly from the measurement error. Among the maxillary teeth, the angle formed between the long axis of the clinical crown and the FOP was smallest in the canine ($P < 0.01$), followed by the first premolars, on both the right and left sides (**Table 1**). Among the mandibular teeth, the angulation was significantly larger in the canine ($P < 0.01$) than in the first and second premolars, and first molar (**Table 1**). The mean crown angulation relative to the FOP was larger in the mandibular teeth than in the maxillary teeth. From these findings, the posterior teeth exhibited more prominent mesial tipping in the upper dentition and, consequently, required more space for alignment than in the lower dentition.

After orthodontic treatment, the crown angulation of the maxillary teethtended to approach approximately 80˚ to 90˚, although the canines still exhibited the smallest angles ($P < 0.01$), followed by the first premolars, on both the right and left sides (**Table 2**). Among the mandibular teeth, the canines, premolars, and first molars presented an angulation of approximately 90˚ to the occlusal plane (**Table 2**).

Comparing crown angulation before and after treatment, the angle relative to the FOP exhibited a significant increase ($P < 0.01$), indicating that the maxillary teeth underwent distally directed uprighting, excluding the first molar (**Table 3**). The mean crown angulation of maxillary first premolar teeth exhibited uprighting after treatment, with an increase in axial angulation from 78.6˚ to 87.3˚, and

Table 1. The crown angulations of the teeth before treatment.

		Mean angulation ± SD, degrees			
Arch	*Side*	*Canine*	*First premolar*	*Second premolar*	*First molar*
Maxilla	Right	75.3 ± 9.6	78.6 ± 5.6	84.7 ± 5.4	89.7 ± 6.3
	Left	79.4 ± 9.9	80.8 ± 6.8	85.2 ± 5.3	88.1 ± 4.3
Mandible	Right	95.5 ± 6.9	91.0 ± 6.7	87.8 ± 5.0	86.8 ± 5.0
	Left	94.3 ± 6.2	87.9 ± 5.9	83.2 ± 4.9	86.1 ± 6.4

** $P < 0.01$.

Table 2. The crown angulations of the teeth after treatment.

		Mean angulation ± SD, degrees			
Arch	*Side*	*Canine*	*First premolar*	*Second premolar*	*First molar*
Maxilla	Right	81.8 ± 5.8	87.3 ± 4.4	88.5 ± 4.7	89.1 ± 4.0
	Left	82.7 ± 3.9	86.8 ± 4.8	89.2 ± 3.8	87.0 ± 3.8
Mandible	Right	89.6 ± 4.9	90.7 ± 4.1	88.7 ± 4.1	88.9 ± 4.8
	Left	87.3 ± 3.2	87.1 ± 4.0	86.1 ± 3.2	85.5 ± 4.7

** $P < 0.01$.

Table 3. Comparison of crown angulations of the teeth before and after treatment.

Arch	Side	Treatment	Canine		First premolar		Second premolar		First molar
Maxilla	Right	pre-	75.3 ± 9.6	**	78.6 ± 5.6	**	84.7 ± 5.4	**	89.7 ± 6.3
		post-	81.8 ±5.8		87.3 ± 4.4		88.5 ± 4.7		89.1 ± 4.0
	Left	pre-	79.4 ± 9.9	*	80.8 ± 6.8	**	85.2 ± 5.3	**	88.1 ± 4.3
		post-	82.7 ± 3.9		86.8 ± 4.8		89.2 ± 3.8		87.0 ± 3.8
Mandible	Right	pre-	95.5 ± 6.9	**	91.0 ± 6.7		87.8 ± 5.0		86.8 ± 5.0
		post-	89.6 ± 4.9		90.7 ± 4.1		88.7 ± 4.1		88.9 ± 4.8
	Left	pre-	94.3 ± 6.2	**	87.9 ± 5.9		83.2 ± 4.9		86.1 ± 6.4
		post-	87.3 ± 3.2		87.1 ± 4.0		83.8 ± 4.9		85.5 ± 4.7

** $P < 0.01$; * $P < 0.05$

from 80.8˚ to 86.8˚ on the right and left sides, respectively. The first premolar exhibited the most prominent change. In contrast, the angulation of the lower premolars and first molars were virtually unchanged after treatment, excluding the canines. Noteworthy, the first molars maintained an angle of approximately 90˚ or an upright position relative to the FOP (Table 3).

The upper and lower dentitions exhibited a considerable increase in dental arch width after treatment. Furthermore, the arch widths at the first and second premolars were significantly increased. Net changes in arch width at the first premolars were largest in the upper and lower dental arches (Table 4). Meanwhile, the rotation of the posterior teeth did not exhibit significant changes after orthodontic treatment (Table 5).

4. Discussion

From previous reports [6] [10] [11], it would be reasonable to assume that the excessive mesially directed axial angulation of the maxillary posterior teeth has a possible association with space deficiency for the alignment of these teeth in the permanent dentition, and results in upper high canine. The present study was, therefore, conducted to identify specific factors relevant to the alignment of posterior teeth contributing to the onset of maxillary high canine in Angle's class I malocclusion using 30 orthodontic treatment case models. The subjects were intentionally standardized by the following condition; with high canine in the maxilla and less than 1 mm ALD in the mandible so that the non-extraction orthodontic treatment was planned and the difference between upper and lower

Table 4. Comparison of the dental arch width before and after treatment.

			Mean ± *SD*, mm				
			Interdistance				
Arch	*Treatment*	*Canine*	*First premolar*		*Second premolar*		*First molar*
Maxilla	pre-	35.8 ± 2.2	41.6 ± 1.7	**	47.8 ± 2.4	**	53.9 ± 2.2
	post-	36.6 ± 1.7	45.0 ± 2.2		50.4 ± 2.4		55.0 ± 2.5
Mandible	pre-	27.8 ± 2.2	34.5 ± 1.8	**	40.2 ± 2.0	**	46.6 ± 2.2
	post-	27.0 ± 1.4	36.3 ± 1.8		42.0 ± 1.6		47.0 ± 2.0

$^{**}P < 0.01$.

Table 5. Comparison of the rotation of posterior teeth before and after treatment.

		Treatment		
Tooth		pre-	post-	
First premolar	*Right*	111.0 ± 7.3	112.2 ± 4.7	NS
	Left	105.4 ± 7.3	107.0 ± 5.5	
Second premolar	*Right*	113.3 ± 7.6	112.9 ± 5.6	NS
	Left	105.4 ± 7.4	107.7 ± 5.6	
First molar	*Right*	75.4 ± 6.5	73.6 ± 6.7	NS
	Left	71.7 ± 5.9	70.5 ± 5.3	

NS: Not significant.

dentitions could be compared and well understood. The results demonstrated that crown angulation was significantly lower, indicating that mesially inclined maxillary lateral and posterior teeth were uprighted distally by non-extraction orthodontic treatment in cases involving prominent crowding and high canines in the upper dentition. Such a tendency was most commonly observed in the premolars among the posterior teeth. With respect to dental arch width, the largest change was evident in the first and second premolar regions, whereas no statistically significant differences were found in the rotation of the posterior teeth.

The maxillary teeth interacted with one another in the alveolar bone, resulting in progressive mesial tipping of the posterior teeth before orthodontic treatment. This tendency was more prominent in the first premolar than in the second premolar, because the first premolar, in general, erupts first among the upper lateral teeth and easily exhibits mesial tipping before the eruption of the canines. Such a phenomenon may be also explained, in part, by the fact that mesial angulation of the erupting maxillary premolar, relative to the reference plane established on panoramic radiographs, was similarly observed in two cases with mixed dentitions in a previous report [11]. In the anterior teeth, the crowns of the canines were located near the apex of the lateral incisors, and the phenomenon of the "ugly duckling stage" was also observed.

The lower posterior teeth, meanwhile, exhibited an approximately upright position perpendicular to the FOP. This maybe explained, in part, by the fact that the maxillary teeth—from the canine to the second premolar—are located closer to one another, resulting in mesial tipping in the alveolar bone than the mandibular teeth on the panoramic radiographs [11]. Dempster *et al.* [12] reported that the long axes of the roots of the upper teeth extend beyond the crowns and tend to converge in the maxilla, whereas those of the lower teeth tend to diverge in the mandible. In addition, their positions remain constant throughout orthodontic treatment in most patients. On the other hand, only the crown angulation of the lower canines was significantly decreased. This may be due to the finding that labial tipping of the canines is indicated during the correction of deep curve of Spee.

In this study, the FOP was used as a reference plane to evaluate tooth crown angulation on both sides. This approach is very useful for evaluating the mesiodistal angulation of teeth in the dentition because the mesiodistal angulation of the crown is particularly important for clinical evaluation of crowding in the dentition. In the development of straight-wire appliances, several studies have investigated angulation of the tooth crown using study models. Andrews [13] and Sebata [14] measured crown angulation in subjects with normal occlusion and found that the premolars and molars in the upper and lower dental arches occupy a position upright to the occlusal plane, which is very similar to results observed after orthodontic treatment in the present study. In addition, the first molar was aligned perpendicularly to the FOP during treatment. A possible reason for this may be that the first molar undergoes the greatest occlusal force during mastication and must support the bite force [15] [16]. Raadsheer *et al.* [17] reported that the direction of bite force, which is perpendicular to the maxillary occlusal plane, was the most prominent measurement.

The largest changes in dental arch width were observed in the regions of the first and second premolars. By comparing the dental arch between normal occlusion and crowding, Howe *et al.* [18] reported that cases involving crowding exhibited narrower and more asymmetric arches than the controls. Moreover, subjects with normal occlusion exhibited wide and U-shaped symmetric arches. Therefore, expansion of a narrow dental arch may lead to successful space regaining, or correction of high canines and mild crowding.

Most of the patients in the present study did not exhibit considerable changes in the rotation of the posterior teeth. Mesial rotation of the posterior teeth can often be a cause of space deficiency; however, the contribution to high canine appeared to be negligible in the samples used in the present study.

Model analysis is a simple method for orthodontists. Its main advantage, when compared with cephalometric analysis, is that crown angulation can be measured more easily and precisely. Furthermore, individual teeth on the right and left sides may be difficult to identify on cephalograms. However, one particular limitation of the present study was its inability to clarify how the mesiodistal angulation of the posterior teeth is generated during occlusal development from mixed to permanent dentition. It is anticipated that three-dimensional imaging techniques [19] [20], which provide additional and more detailed information about the positional relationship between the first molar root and the lateral teeth germs, would be useful in a future longitudinal study.

5. Conclusion

Based on the results of this study, both up righting of mesially tipped lateral teeth and expansion of narrow dental arches could prove to be keys to success in space regaining or correction of high canines and mild crowding. Therefore, it maybe concluded that mesial tipping of the maxillary posterior teeth and a narrow dental arch can limit the space required for the alignment of permanent posterior teeth, leading to the onset of maxillary high canine. It is also emphasized that upper high canine is not caused by a tooth-jaw discrepancy, which is a common and essential cause of typical crowding.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

References

[1] van der Linden, F.P.G.M. (1974) Theoretical and Practical Aspects of Crowding in the Human Dentition. *Journal of American Dental Association*, **89**, 139-153. https://doi.org/10.14219/jada.archive.1974.0308

[2] Sakuda, M., Kuroda, Y., Wada, K. and Matsumoto, M. (1976) Changes in Crowding of Teeth during Adolescence and Their Relation to the Growth of the Facial Skeleton. Trans European Orthodontic Society (Special Edition), 93-104.

[3] Leighton, B.C. and Hunter, W.S. (1982) Relationships between Lower Arch Spacing/Crowding and Facial Height and Depth. *American Journal of Orthodontics*, **82**, 418-425. https://doi.org/10.1016/0002-9416(82)90191-9

[4] Doris, J.M., Bernard, B.W., Kuftinec, M.M. and Stom, D. (1981) A Biometric Study of Tooth Size and Dental Crowding. *American Journal of Orthodontics*, **79**, 326-336. https://doi.org/10.1016/0002-9416(81)90080-4

[5] Graber, T.M. and Vanarsdall Jr., R.L. (1994) Orthodontics. In: Graber, T.M., Ed., *Current Principles and Techniques*, 2nd Edition, CV Mosby Co., St Louis, 321-327.

[6] Masunaga, M., Ueda, H. and Tanne, K. (2012) Changes in the Crown Angulation and Dental Arch Widths after Nonextraction Orthodontic Treatment: Model Analysis of Mild Crowding with High Canines. *Open Journal of Stomatology*, **2**, 188-194. https://doi.org/10.4236/ojst.2012.23034

[7] Marcotte, M.R. (1976) The Use of the Occlusogram in Planning Orthodontic Treatment. *American Journal of Orthodontics*, **69**, 655-667.

https://doi.org/10.1016/0002-9416(76)90148-2

[8] Champagne, M. (1992) Reliability of Measurements from Photocopies of Study Models. *Journal of Clinical Orthodontics*, **26**, 648-650.

[9] Kircelli, B., Pektas, Z. and Kircelli, C. (2006) Maxillary Molar Distalization with a Bone-Anchored Pendulum Appliance. *Angle Orthodontist*, **76**, 650-659.

[10] Ueda, H., Masunaga, M., Concepcion, C. and Tanne, K.(2016) The Influence of Erupting Lateral Teeth on Maxillary Anterior Crowding in Two Angle Class I Malocclusion Cases with High and Low Angles. *APOS Trends in Orthodontics*, **6**, 105-112. https://doi.org/10.4103/2321-1407.177967

[11] Masunaga, M., Ueda, H., Shibaguchi, T. and Tanne K. (2016) Change in the Mesiodistal Axial Inclination of the Maxillary Lateral Teeth during the Mixed Dentition Stage: Morphometric Analysis of Panoramic Radiographs from Two Cases of Mild Crowding with a High Canine. *APOS Trends in Orthodontics*, **6**, 24-30. https://doi.org/10.4103/2321-1407.173721

[12] Dempster, W.T., Adams, W.J. and Duddles, R.A. (1963) Arrangement in the Jaws of the Roots of the Teeth. *Journal of American Dental Association*, **67**, 779-797. https://doi.org/10.14219/jada.archive.1963.0364

[13] Andrews, L.F. (1989) Straight-Wire: The Concept and Appliance. 2nd Edition, Wells Co., San Diego, 25-33.

[14] Sebata, E. (1980) An Orthodontic Study of Teeth and Dental Arch form on the Japanese Normal Occlusions. *Shikwa Gakuho*, **80**, 945-969.

[15] Kumagai, H., Suzuki, T., Hamada, T., Sondang, P., Fujitani, M. and Nikawa, H. (1999) Occlusal Force Distribution on the Dental Arch during Various Levels of Clenching. *Journal of Oral Rehabilitation*, **26**, 932-935. https://doi.org/10.1046/j.1365-2842.1999.00473.x

[16] Sultana, M.H, Yamada, K. and Hanada, K. (2002) Changes in Occlusal Force and Occlusal Contact Area after Active Orthodontic Treatment: A Pilot Study Using Pressure-Sensitive Sheet. *Journal of Oral Rehabilitation*, **29**, 484-491. https://doi.org/10.1046/j.1365-2842.2002.00849.x

[17] Raadsheer, M.C., van Eijden, T.M.G.J., van Ginkel, F.C. and Prahl-Andersen, B. (1999) Contribution of Jaw Muscle Size and Craniofacial Morphology to Human Bite Force Magnitude. *Journal of Dental Research*, **78**, 31-42. https://doi.org/10.1177/00220345990780010301

[18] Howe, R.P., McNamara, J.A. and O'Connor, K.A. (1983) An Examination of Dental Crowding and Its Relationship to Tooth Size and Arch Dimension. *American Journal of Orthodontics*, **83**, 363-373. https://doi.org/10.1016/0002-9416(83)90320-2

[19] Tong, H., Kwon, D., Shi, J., Sakai, N., Enciso, R. and Sameshima, G.T. (2012) Mesiodistal Angulation and Faciolingual Inclination of Each Whole Tooth in 3-Dimensional Space in Patients with Near-Normal Occlusion. *American Journal of Orthodontics Dentofacial Orthopedics*, **141**, 604-617. https://doi.org/10.1016/j.ajodo.2011.12.018

[20] Tong, H., Enciso, R., Elslande, D.V., Major, P.W. and Sameshima, G.T. (2012) A New Method to Measure Mesiodistal Angulation and Faciolingual Inclination of Each Whole Tooth with Volumetric Cone-Beam Computed Tomography Images. *American Journal of Orthodontics Dentofacial Orthopedics*, **142**, 133-143. https://doi.org/10.1016/j.ajodo.2011.12.027