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A Study of Crown and Root Angulation on Maxillary First and Second Bicuspids

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Abstract

A STUDY OF CROWN AND ROOT ANGULATION ON MAXILLARY FIRST AND SECOND BICUSPIDS

by

Craig A. Chamberlain, D.D.S.

Pre-adjusted bracket systems offer the clinician the convenience of working with both fewer in number and smaller in magnitude adjustments of an archwire. The purpose of this in vitro study was to examine the normal variations in crown angulation of individual maxillary bicuspids, in a simulated flat plane of occlusion, and how this relates to marginal ridge discrepancies. A second purpose of this study was to examine these same teeth for the angulations of the roots. Fifty maxillary first bicuspids and thirty eight second bicuspids from the Loma Linda University Dental School restorative dentistry department were, in a flat plane of occlusion, examined. These teeth, with respect to variation in angular measurements of the roots and crowns, were measured at the level of the marginal ridges. From these measurements, the data analysis calculated the mean and standard deviation for angulation, mean difference of measurements, a linear regression relating crown angulation to root angulation, and a millimeter measurement for marginal ridge discrepancy.

Conclusions are presented showing the first maxillary bicuspid to have a mean negative crown angulation of 0.52 degrees, mean

distal root tip of positive 8.08 degrees, and a marginal discrepancy of only 0.072mm. The second maxillary bicuspid exhibited mean measurements of 3.70 degrees of positive crown angulation, distal root tip of positive 3.68 degrees, and a marginal ridge discrepancy of 0.48mm.

LOMA LINDA UNIVERSITY

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Each person whose signature appears below certifies that this thesis, in his opinion, is adequate in scope and quality as a thesis for the degree Master of Science.

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INTRODUCTION AND LITERATURE REVIEW

As orthodontists, it is important that we have a thorough understanding of anatomical form and occlusal function of the dentition. The dental anatomy and occlusion literature has had much to say about the dental arches. These comments have been based almost wholly on data relating to measurements of the crowns of the teeth, plaster models of dentitions, the experiences of clinicians using articulators and those who design denture teeth. Few have distinguished between the alveolar arches and the dental arches proper.

As early as the late 1880's Angle noted that a regular arch curvature could be identified along the line of occlusal contact from the lingual cusps of the upper molars and the opposed sulci of the lower molars forward to the incisor contact points. Angle, who made much of the functional significance of this line, referred to it as being paraboloid shaped. It is noteworthy that all of the dental arch curve describers were apparently seeking a basic mean pattern of "ideal." When in 1899 Angle introduced his classification of anomalous occlusions and the term "malocclusion," he went a step further and made it clear that the forces of cuspal interdigitation were the essentials for keeping the teeth in alignment[1]. This outlook argued for adaptive mechanisms rather than for "ideal" patterns which ignore variance.

Practically all teeth are aligned in their arches with varying degrees of inclination of their axial centers relative to a vertical line both in a mesiodistal and faciolingual direction. In the hypothetically ideal state, the various axial inclinations of teeth will result in a continuity of tooth forms. Usually the cusp tips of the posterior teeth coform in alignment to a fairly even curve in the anteroposterior direction (curve of Spee). A transverse occlusal curve also exists for the posterior tooth and as the curve of von Spee it is concave above and convex below (transverse curve or curve of Wilson).

Monson's[2] belief that the occlusal surfaces of the natural dentition are aligned three dimensionally on the surface of a sphere has been questioned[3]. The teeth appear to align themselves upon two unrelated two-dimensional curves, an anteroposterior curve and a mediolateral curve. The degree of axial root angulation from the vertical line perpendicular to the occlusal table varies for each tooth and to a greater or lesser degree for each tooth type[3].

Prior to the early 1950s traditional guidelines had been used by orthodontists to indirectly assess occlusion. One such guideline is the classic concept of the interarch relationship of the permanent first molars. In 1899 Angle[1] postulated that an absolute necessity of optimal occlusion is the mesiobuccal cusp of the maxillary first molar, occluding in the buccal groove between the mesial and middle buccal cusps of the mandibular first molar. An additional guideline (1953) for judging one aspect of occlusion uses roentgenographic cephalometry. The guideline set forth recommended inclinations of the maxillary and mandibular central incisors for various interjaw relationships[4]. However, this guideline cannot be applied intraorally or with the cast itself. To this end, in 1954, Stoller[14] postulated his anteroposterior relationship of the maxillary first molar to the mandibular first and second molar. He concluded that there must be three criteria met on both left and right side of the arch to achieve ideal buccal occlusion: 1) the first molar relationship was Angle's Class I, 2) the distal surface of the distal marginal ridge of the upper first permanent molar was in contact with the mesial surface of the mesial marginal ridge of the lower second molar, 3) the mesiolingual cusp of the upper first molar seated in the central fossa of the lower first molar. Therefore, in the late 1960s Ricketts postulated that the key to occlusal harmony was the maxillary second premolar and proposed a set of the guidelines for optimal occlusion. "Without normal relationships and positions of upper and lower molar teeth, the distal inclines of the upper second premolar cannot achieve the normal contact relation with the mesial incline of the lower first molar, and the tip of the mesiobuccal cusp of the upper first molar is slightly distal to the buccal groove of the lower first molar, contrary to common concepts[5]."

It was in the early 1970s Andrews[6] postulated the Six Keys of Occlusion which makes it possible to assess occlusion from facial and occlusal sites without using measuring devices.

Andrews defines Key II as crown angulation. Crown angulation is the angle formed by the facial axis of the clinical crown (FACC) and a line perpendicular to the occlusal plane.

The FACC, as defined by Andrews[6], is for all teeth, except molars, the most prominent portion of the central lobe on each crown's facial surface (Fig. 1). Crown angulation is considered positive when the occlusal portion of the FACC is mesial to the gingival portion, negative when distal. In demonstrating ideas about axial positioning of the teeth subjective clinical averages have been used in the past. Dempster[7] showed that the maxillary first biscuspids exhibited 9.6 and 10.4 degrees of distal angulation of the buccal and lingual roots respectfully. The second maxillary bicuspids exhibited 8.6 degrees of distal angulation. Dempster's technique for measuring angulation, taken on the 13 male skulls, was measured on stone models of the maxillary alveoli set in a plate of plaster. Orthodontic wire was placed in the alveolus for each root to represent the longitudinal axis of that root. The root angulation measurement was taken as the amount of degrees the wire slanted past vertical[7]. Unfortunately, the experimental design did not establish clear-cut parameters in the axial positioning of the crowns with respect to the roots.

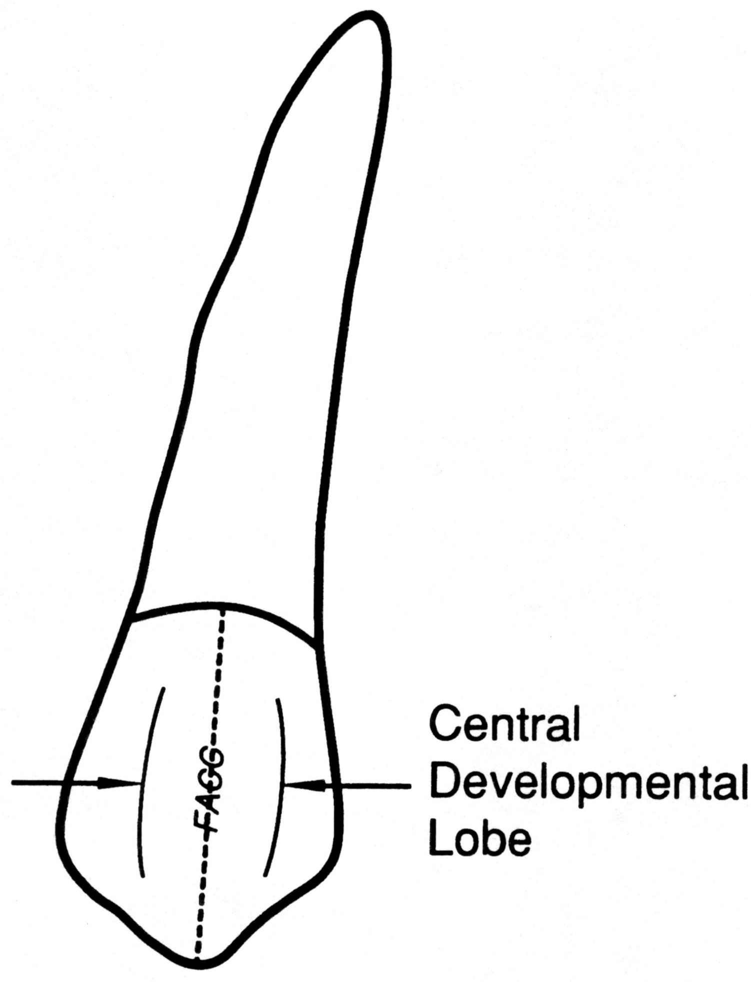


Fig. 1 Diagram showing the facial axis of the clinical crown (FACC) as a line on the most prominent portion of the central developmental lobe of crown.

The importance of crown and root angulation for proper occlusion is apparent. The maxillary and mandibular teeth must have the proper angulation to relate not only to the adjacent tooth in the arch but also to the opposing arch. Orthodontic treatment usually involves a blending of two or three phases. Initially the teeth in each arch are leveled, aligned, and extraction sites, if present, are closed. Concurrently, the interjaw and intraarch relationships may be made more harmonious. The last phase involves fine-tuning the positions of the teeth to optimal occlusal standards. Fixed appliances with edgewise appliance slots have proven to be best for these procedures because the slot permits three-dimensional control. Historically, bends in the arch wires were introduced to change the relationship of the teeth. However, it had been a goal to reduce the number of bends[10,11] in the arch wire to cause these dimensional changes reducing the number of archwire bends had been thought of before the introduction of the Straight-Wire Appliance which was introduced in 1970.

In 1928 Angle[9] had suggested angulating the entire bracket on the band to free the archwire of bends in the "second order[9]." Holdaway[10], in 1952, suggested bracket overangulation for teeth on either side of an extraction site to reduce the second-order wire bends, and bracket angulation. This, however, was a process not a built-in feature. In 1957 Jarabak incorporated slot inclination to reduce the need for third-order archwire bends, so he is credited for being first to actually build any guidance into the bracket[11,12].

In 1959 John J. Stifter was granted a U.S. patent for an edgewise bracket comprising a male and a female component. This was the first edgewise bracket designed to build guidance into all three planes of space.

By the early 1960s there were individualized bands for each tooth type, but not individualized brackets. Edgewise brackets with inclined slots were available in 5 degree increments from 5 degrees to 25 degrees. However, the bands were designed to seat to the marginal ridges and this eliminated the need for angulation of the bracket on the band. With the advent of direct-bonding brackets, orthodontists began to realize the advantage of angulating the bracket and of inclining the slot, but there was no consensus about the amount of angulation and inclination appropriate for each tooth type, nor on the landmark upon which to place the bracket.

A suitable bracket site for the purpose of straight wire technique has three criteria. First, a bracket located at this site will not interfere with either the gingiva or with the opposing dentition. Second, the angulation and inclination of the crown at the site will have a consistent angular relationship to the plane of each tooth's occlusal surface at all times and to the occlusal plane of the arch when the teeth are optimally positioned. The third criterion is not nearly as well defined. Andrews' straight wire appliance design states that the middle of each bracket site must share the same plane or surface when the teeth in an arch are optimally positioned[13]. The site that meets these requirements is the area in immediate proximity to the facial point of the crown. Roth's placement is not the FA point but at a constant millimeter height similar to other prescriptions which use a millimeter measurement from the incisal surface for appropriate placement.

The concept of programming tooth guidance into the bracket rather than into the wire is based on the recognition that extensive similarities prevail in the morphology of normal tooth types, and in their positions when they are optimally occluded. It is literally possible to have programmed brackets for each problem scenario. Andrews studied 120 untreated cases to gain the basis for his Keys to occlusion. Key II, crown angulation, was determined by using an arch-shaped plastic template and protractor measuring off plaster models[13]. The arch-shaped plastic template was positioned over the occlusal surfaces to represent the occlusal plane of the arch. The base of the protractor was placed on the plastic template and the protractors readout arm was adjusted to parallel the crown's FACC. The angulation of the crown was read from where the center line of the readout arm fell on the protractor's scale. He found the maxillary first and second bicuspids both demonstrated two degrees of positive angulation. Just as Dempster's study did not differentiate between the crown and roots, Andrews' study did not measure the angular relationship between long axis of the crown and the long axis of the root.

It is evident from Andrews' study that if an orthodontist wishes to maximize the effectiveness of a programmed bracket system, they should have a thorough understanding of the effects of the prescription they order.

The purpose of this research study was to use marginal ridge vertical occlusal contacts as a reference plane and frome this plane evaluate crown and root long axis angulation of the maxillary first and second bicuspids in an in vitro simulated flat curve of Spee occlusion. In this study, the null hypothesis was that in this in vitro system there was no significant difference between the maxillary first and second bicuspid crown angulation and zero.

METHODS AND MATERIALS

In this study the marginal ridge to crown long axis and marginal ridge to root long axis angular relationship in extracted maxillary bicuspids was investigated. The original sample, randomly selected from a collection of the restorative dentistry department at Loma Linda University School of Dentistry, Loma Linda, California, consisted of 60 maxillary first bicuspids and 60 second bicuspids. These teeth were to meet strict criteria set by the author. Dr. Daniel Tan, Professor dental tooth anatomy and morphology at Loma Linda University School of Dentistry, inspected the teeth and tooth selection for the study was limited only to those that met the set parameters. The criteria consisted of, but were not limited to: all teeth must be free of restorations, defects, and extreme occlusal wear. There are certain class traits (Fig. 2) diagnostic for maxillary premolars: (1) Maxillary premolars have two major cusps that are approximately equal in size and prominence. (2) Maxillary premolar crowns, as viewed from the occlusal aspect, are distinctly wider buccolingually than mesiodistally. The mesiodistal and buccolingual dimensions of mandibular premolars more closely approximate one another. (3) The buccal profiles of maxillary premolars (as viewed from the proximal aspects) show only a slight lingual inclination from the height of contour to the cusp apex. (4) The left and right side teeth for each invidual are not significantly different from one another[15].

(5) The height of contour of the lingual profiles of maxillary premolars is located approximately at the midportion of the crown, and all teeth selected fell within the description in Table 1.

Table 1.

Criterion for selection teeth

Maxillary Premolars	Crown Height (mm)	Tooth Length (mm)	Mesiodistal Crown Diameter (mm)	Bucco-lingual Crown Diameter (mm)
First	8.5mm ± 2mm	23.5mm ± 4mm	7.0mm ± 2mm	9.0mm ± 2mm
Second	8.5mm ± 2mm	22.5mm ± 4mm	7.0mm ± 2mm	9.0mm ± 2mm

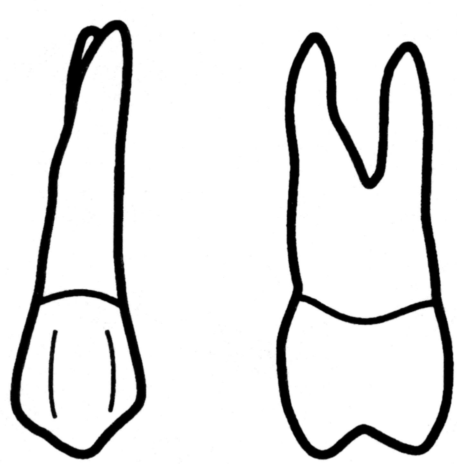


Fig. 2 Buccal and proximal view maxillary bicuspid

After final analysis of the initial teeth, the researched sample consisted of 50 maxillary first bicuspids and 38 maxillary second bicuspids.

The teeth were mounted in a jig designed for the exclusive purpose of holding the teeth, with each tooth being held only at the height of mesial and distal margin ridges, along their mesial-distal plane (Fig. 3). Each tooth, as indicated by gnathological studies[3,5,8], had its own precise custom fit to assure the mesial and distal marginal ridges are the only occlusal contacts (Fig. 4). All records were taken with the jig and the reference plane on the x-axis, which gave the actual crown and root angulation when the marginal ridges were at equal heights. This satisfied the treatment objective that bicuspid marginal ridge heights should be level and equal with a flat curve of Spee present.

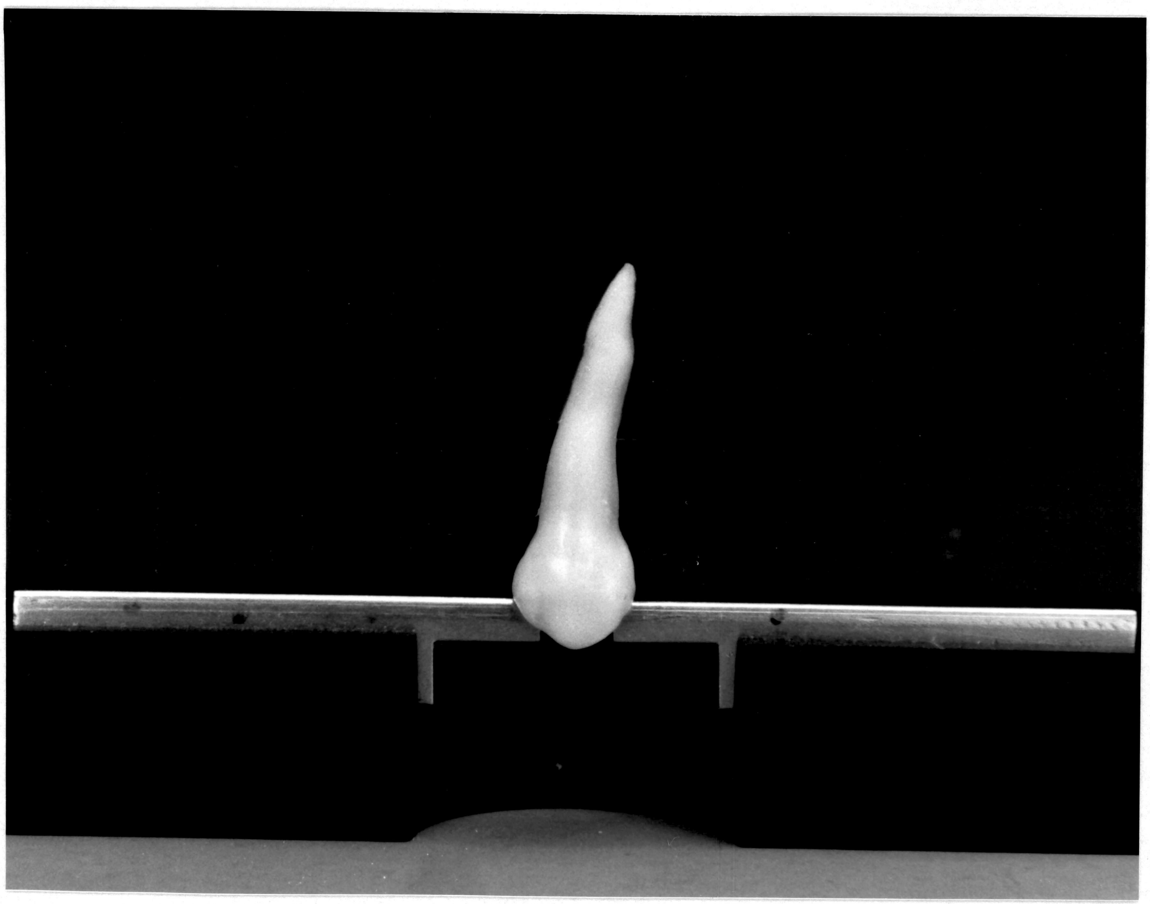


Fig. 3 Maxillary tooth fixed in mounting jig

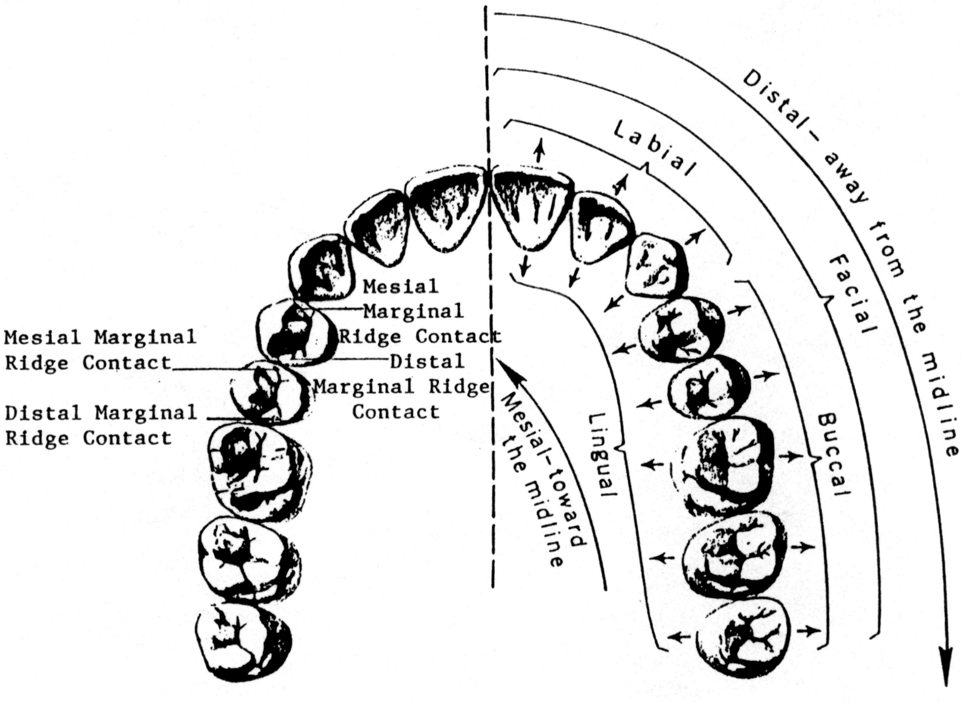


Fig. 4 Gnathological maxillary bicuspid occlusal contacts

All measurements were made with the OMIS II optical measurement inspection system manufactured by: Ram Optical Instrument, Inc., using the Auto-map X-Y-Z Measurement Analysis Program, mounted over the jig at a reference distance that produced a 20X size enlargement. The OMIS II 6x12 provides three-axis measurement capability. Linear scales provide standard measurement resolution of .000040 inches (1 micron) to the Auto

MAP P.C. based software or digital readout system. The instrument combines fiber optic illumination, solid state CCD color camera, monitor, and a crosshair generator to provide microscope-type viewing in the 20X to 250X range. The image clarity and detail on the video display allows an operator to realize .000050" optical video positioning resolution (Fig. 5).

Fig. 5 OMIS II optical measurement inspection system

The jig was labeled with an incremental scale to ensure proper enlargement, and provide a horizontal reference plane. Two best fit lines, delineated by the 7 point analysis of the tooth, labeled each tooth's facial axis of the clinical crown (FACC)[13] and the long axis of the root surface (Fig. 6). It has been documented that dilacerations of the roots occurred in the apical third of the roots[3,8]. Therefore, to remove this variable, the apical 1/3 was disregarded and only the cervical 2/3 of the root was used to determine its long axis. The system then recorded the angulation of the crown and root long axes. Both angles (1 and 2) were independent of one another, but were analyzed both independently and together. The equations used to determine absolute angular values were:

For the right side crown (angle 1) and root (angle 2)

90^{o}-(crown angle 1 or root angle 2)=(X^{o} from vertical)

For the left side crown (angle 1) and root (angle 2)

(crown angle 1 or root angle 2)-90^{o}=(X^{o} from vertical)

Reliability tests were included in this study to verify the repeatable reliability of both the OMIS II and the placement of the teeth on the mounting jig. Both involved, after recording data for the entire sample, selecting the last ten samples, remounting the teeth, and rerecording data for those last ten samples. A paired t-test was done and was then used to check the consistency of each of individual parameters within the last ten samples.

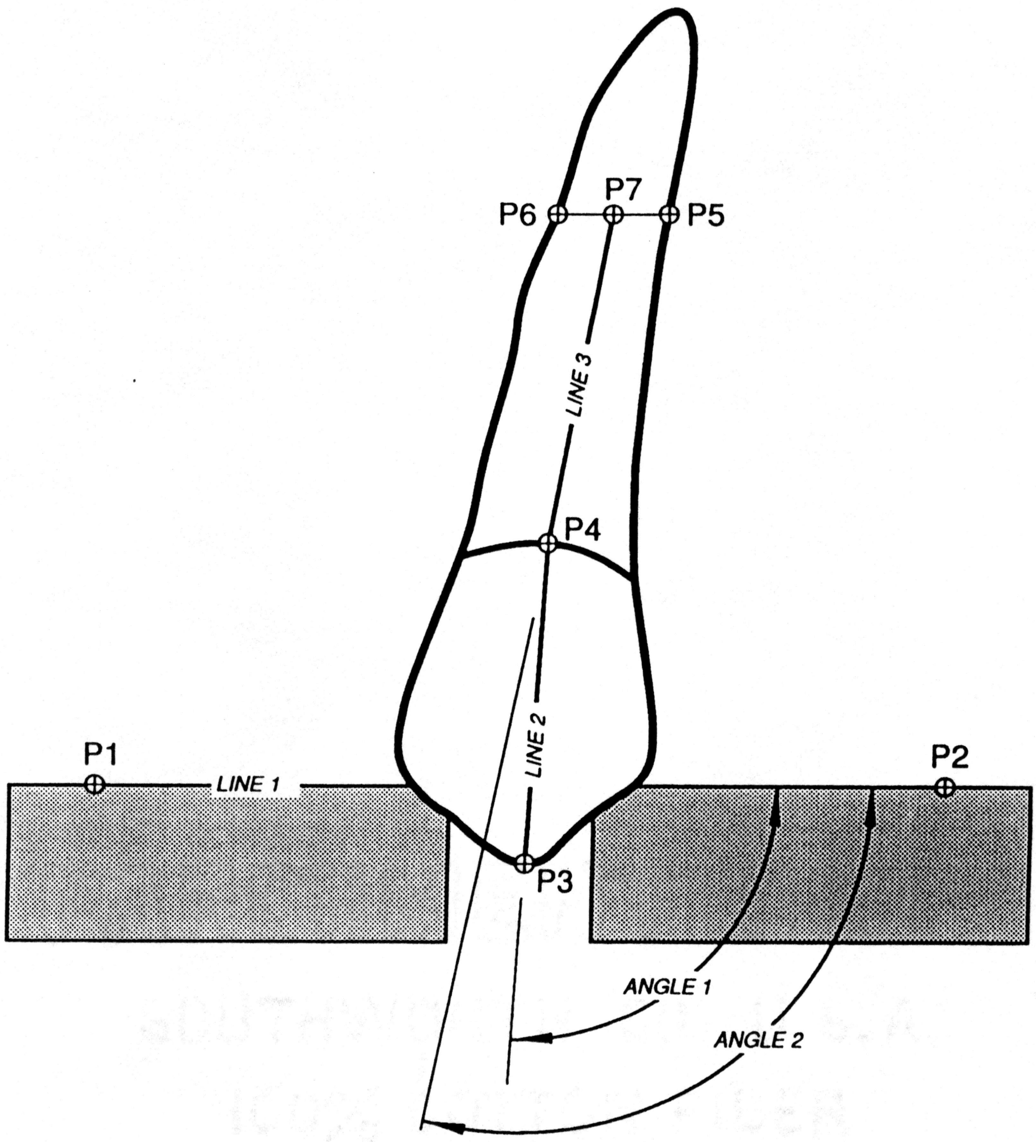


Fig. 6 Two best fit lines, delineated by the 7 point analysis of the tooth, labeled each tooth's FACC (line 2) and the long axis of the root surface (line 3).

RESULTS

Table 2 lists the descriptive statistics for maxillary first premolars crown and root angulations of the fifty individual teeth measured in this study.

Table 2.

Descriptive Statistics for Crown and Root Angulations

Maxillary First Premolar n=50	Mean Degrees	Standard Deviation	Standard Error of Mean
Crown	-0.52°	3.44°	0.49°
Root	$+8.08^{\circ}$	4.35°	0.62°

From Table 2. it can be seen that the maxillary first premolars showed 0.52 degrees of negative angulation. To reaquaint the reader, angulation, as defined by Andrews, is considered positive when the occlusal postion of the FACC is mesial to the ginginval portion, negative when distal. The roots demonstrated a distal angulation of +8.08 degrees. The correlation coefficent and linear regression, to determine the relationship of the crown to root as the dependent variable, was run and is presented in Table 3.

Table 3.

Correlation Coefficient and Linear Regression for Predicting Root Angulation from Crown Angulation

Correlation Coefficient	Coefficient of Determ	Estimated Constant Term	Regression Coefficient
0.61	0.37	8.48	0.77

Therefore, as can be calculated from Table 3, the linear regression determined that the amount of variability in root explained (due to) crown is 36.8%. The equation which relates crown to root is: Root angulation = 8.48^{o} + $.77^{o}$ per 1^{o} positive crown angulation. This formula predicted the root angular value from a given crown angular value.

The following two tables list the descriptive statistics for the crown and root angulation of the maxillary second premolars. The correlation coefficient and linear regression to determine the relationship of the crowns to the roots as the dependent variable was determined and the results are presented in or tabulated from Table 4

Table 4.

Correlation Coefficient and Linear Regression for Predicting Root Angulation from Crown Angulation

Correlation Coefficient	Coefficient of Determ	Estimated Constant Term	Regression Coefficient
0.60	0.36	0.22	0.94

The linear regression determined the amount of variability in root explained (due to) crown was 36.32%. The equation which relates crown to root is: Root Angulation = 0.22^{o} + $.94^{o}$ per 1 degree of positive crown angulation. Again this equation predicted the root angular value from a given crown angular value.

In the case of the maxillary second bicuspids, they exhibited positive angulation for the crown and distal angualtion for the root means. The mean degrees for crowns and roots was +3.70 degrees and +3.68 respectively. The standard deviations, as seen in Table 5, was 3.71 for crowns and 5.77 for the roots.

Table 5.

Descriptive Statistics for Crown and Root Angulations

Maxillary Second Premolar n=38	Mean Degrees	Standard Deviation	Standard Error of Mean
Crown	+3.70°	3.71°	0.60°
Root	+3.68°	5.77°	0.94°

A paired t-test was done on the last ten teeth to check the accuracy of the experimental method and the repeatability of the study. The two-tailed probability for the crowns was found to be P value = 0.055. This was significant. However, because the mean difference was found to be only 0.5 of a degree there was only slight significance. The two-tailed probability of the roots proved to be highly insignificant at P value = 0.84 with the mean difference of only 0.08 of a degree. Included in the appendix are absolute angular measurements, histograms of the crown and root angular values, and the break down of variations in the paired t-tests.

DISCUSSION

With the advent of the preadjusted applianced, there have been questions raised regarding which of the prescriptions available gives the most economical and efficient mode of treatment. The results of this study (Fig. 7) showed a negative angulation of 0.52 degrees with the root showing a distal angulation of +8.08 degrees and a mean difference of approximately 0.5 degrees of angulation. The angulation of the maxillary first bicuspid crown and root analyzed together gives basically similar (+7.56 degrees distal angulations) results to those found in previous studies[7,8].

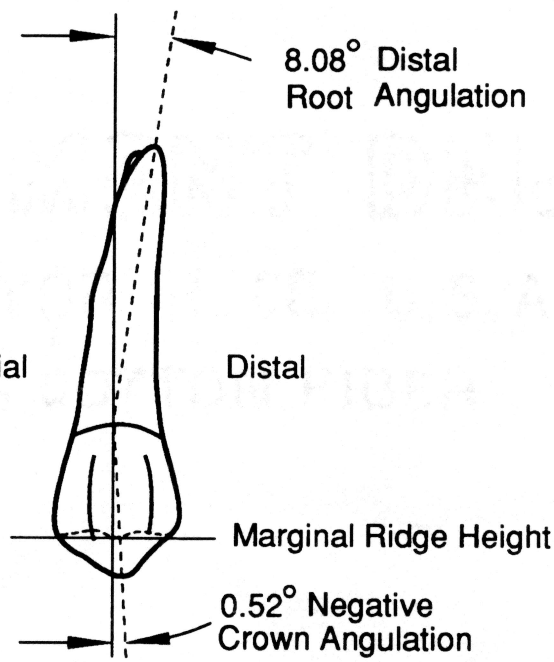


Fig. 7 Crown and Root Angulations of Maxillary First Premolars

The results for the maxillary second bicuspid, as seen in Figure 8, demonstrated that the crown and root angulations were nearly identical. However, the results were different from previous studies for both the crown, root, and analyzed together[7,8]. Dempster's study demonstrated approximately 9 degrees of distal tooth tip, Wheeler showed approximately the same, and Andrew's prescribed two degrees of positive crown angulation. This study exhibited +3.70 degrees of crwon angulation and was +3.68 distal root tip. Overall, as analyzed together, the total tooth distal angulation was +3.69 degrees.

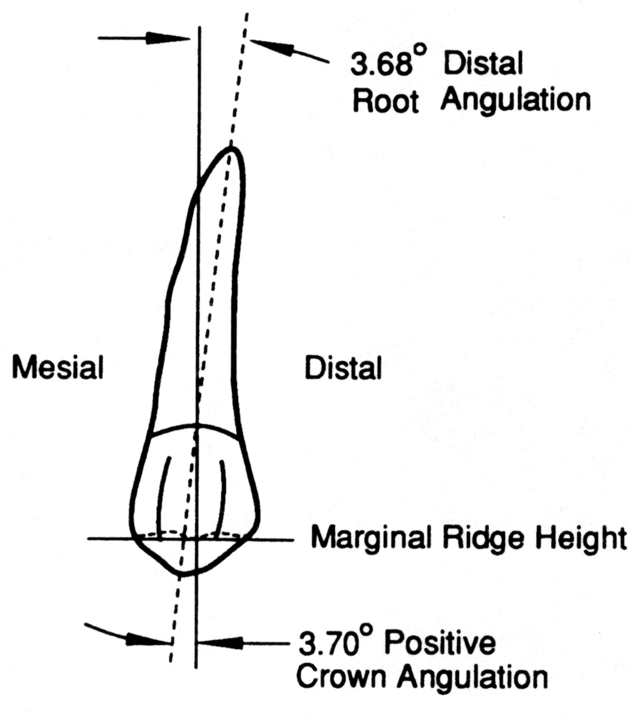
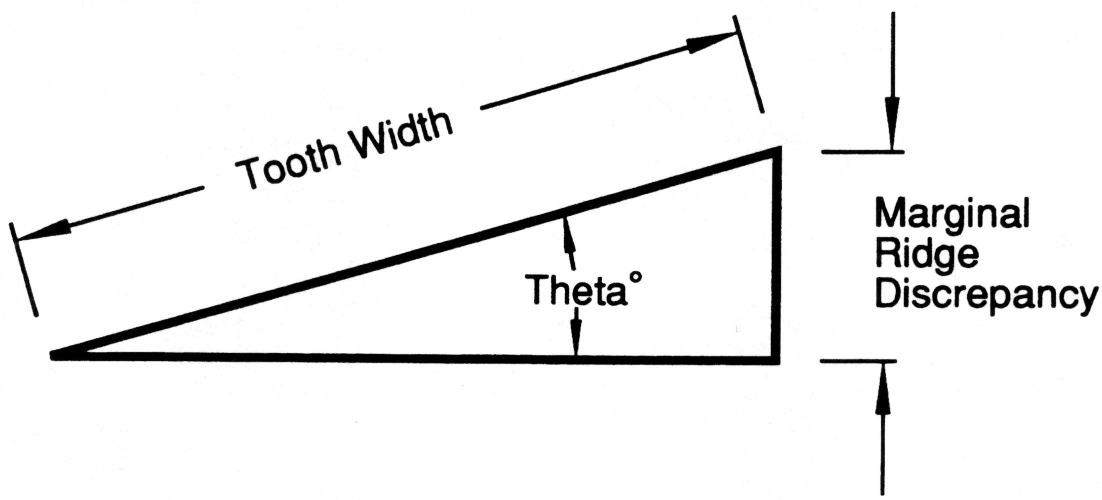


Fig. 8 Crown and Root Angulation Maxillary Second Bicuspids

As seen from Table 2 and 5, both the first and second maxillary bicuspids do not exhibit zero degrees of crown angulation. Therefore, Fig. 9 describes the trigonometric equation used to determine the marginal ridge discrepancy displayed when the teeth are placed at zero degrees angulation (zero degree brackets).



$$\text{Marginal Ridge Discrepancy} = [\text{Sine (Theta)}] * [\text{Tooth Width}]$$

Fig. 9 Trigonometric equation to illustrate marginal ridge discrepancy

As viewed in Figure 10 and 11, the millimeter differences between marginal ridges heights for an 8mm wide maxillary bicuspid[3,8] were 0.072 mm, (which is difficult to discern clinically), for the maxillary first and 0.48 mm, (which an operator can clinically observe), for the second bicuspids.

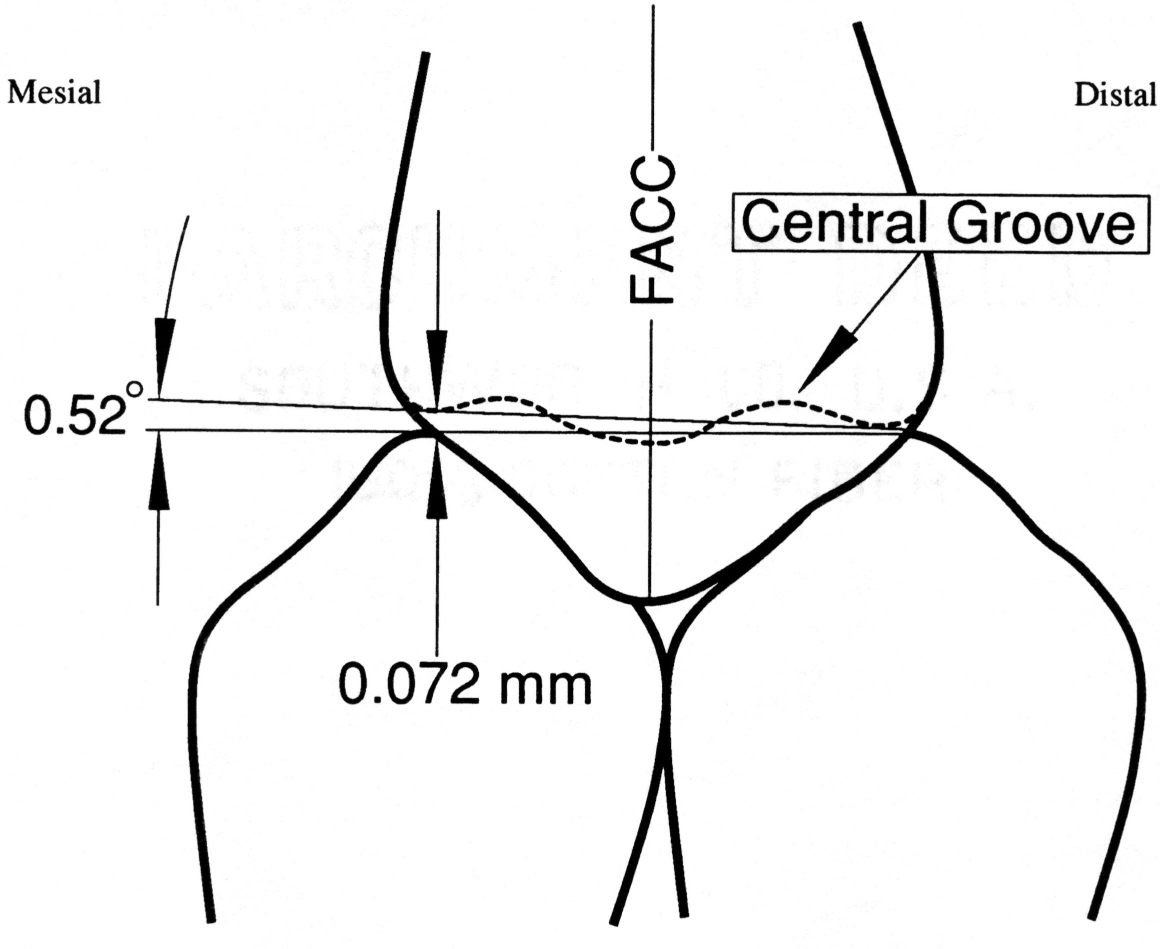


Fig. 10 Maxillary left first bicuspid marginal ridge discrepancy measurement

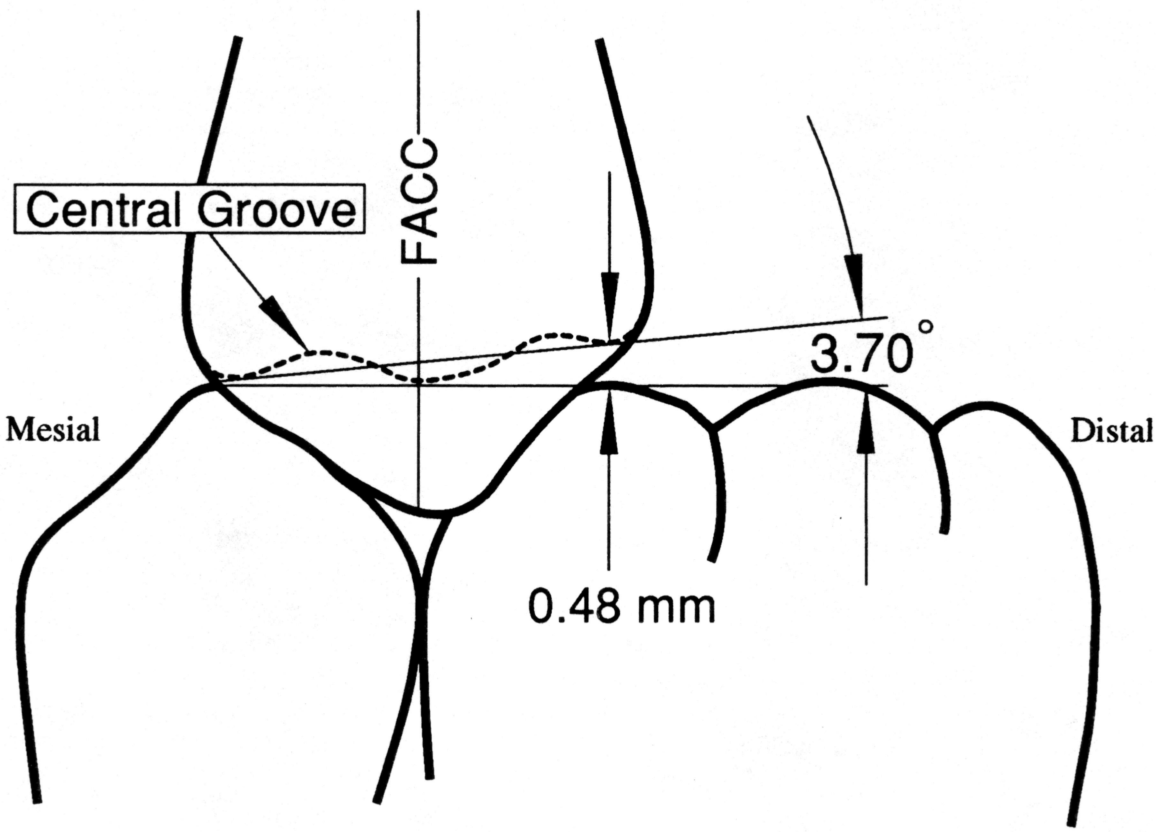


Fig 11. Maxillary left second bicuspid marginal ridge discrepancy measurement

What is the limit of clinical accuracy with respect to orthodontic adjusted prescriptions? In pursuit of ultimate excellence, questions remain about the suitability of the "one-size-fit-all" approach. One has to remember that this study was performed at substantial magnification in a laboratory setting where the operator had great control over the quality of the dentition and could manipulate these teeth into the ideal positions. Realistically, the accuracy of bracket placement will play the major role in the eventual alignment of the dentition no matter which prescription the orthodontist chooses to use.

Although this study gave very repeatable results, within 0.5 degrees, errors in results may have been due to the following factors:

1) Undetected marginal ridge wear
2) Incorrect identification of landmarks on the teeth
3) Inaccuracy of the OMIS II measuring device
4) Inaccuracy in the placement of the teeth on the jig

CONCLUSIONS

This study analyzed the crown and root angulations of 50 maxillary first premolars and 38 second premolars. The samples were placed, at the height of marginal ridges, on a specifically designed jig. The jig was mounted on the OMNIS II measuring device and the following are some of the conclusions that came out of this data:

1) The maxillary first premolar crown showed a negative 0.52 degrees of angulation and the root showed positive 8.08 degrees of distal angulation. The amount of root variability due to crown is 36.8% and the equation for root angulation is: Root Angulation = 8.48^{o} + $.77^{o}$ per 1^{o} distal crown angulation. The marginal ridge millimeter discrepancy was found to be 0.072 mm, which would be difficult to view clinically.

2) The maxillary second premolar crown showed a positive angulation of 3.70 degrees and the root showed positive 3.68 degrees distal angulation. The amount of root variability due to crown is 36.32% and the equation for root angulation is: Root Angulation = 0.22^{o} + 0.94^{o} per 1^{o} distal crown angulation. The marginal ridge millimeter equivalent was found to be .48mm which can be clinically viewed.

3) Reliability tests showed both the crown, root, and the computer input to have a mean difference of only 0.5 degrees.

4) If the study is taken at face value, with the $+8.08^{0}$ and $+3.70^{0}$ distal root angulation for the maxillary first and second bicuspids respectively, can one ideally parallel the roots? In a clinical sense, root approximation is probably a more correct comparison.

If the marginal ridges show variations, then to have a straightwire appliance the angulation of the bracket must mirror that marginal ridge variation. This variation occurs approximately 36% of the time. Therefore, it may prove insignificant clinically to have positive angulation in the bracket design It is hoped that the results of this study will encourage other researchers to examine the anatomy of individual teeth and incorporate this perspective to improve the efficiency of the modern orthodontic appliance.

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APPENDIX

Table 1.
Paired T-Test (measurements made in degrees)

	Sample 1	Sample 2	Variance
Crown	93.40	92.48	0.92
	90.08	88.88	1.20
	86.03	86.30	-0.27
	81.47	81.78	-0.31
	100.23	100.52	-0.29
	89.02	87.90	1.12
	92.60	91.20	1.40
	85.70	84.57	1.13
	93.23	93.07	0.16
	82.85	82.93	-0.08
Root	87.37	88.47	-1.10
	96.00	95.18	0.82
	92.65	93.07	-0.45
	90.67	90.67	0.00
	94.23	95.42	-1.19
	84.03	81.55	2.48
	94.68	94.82	-0.14
	87.53	88.98	-1.45
	80.88	80.10	0.78
	82.43	81.37	1.06

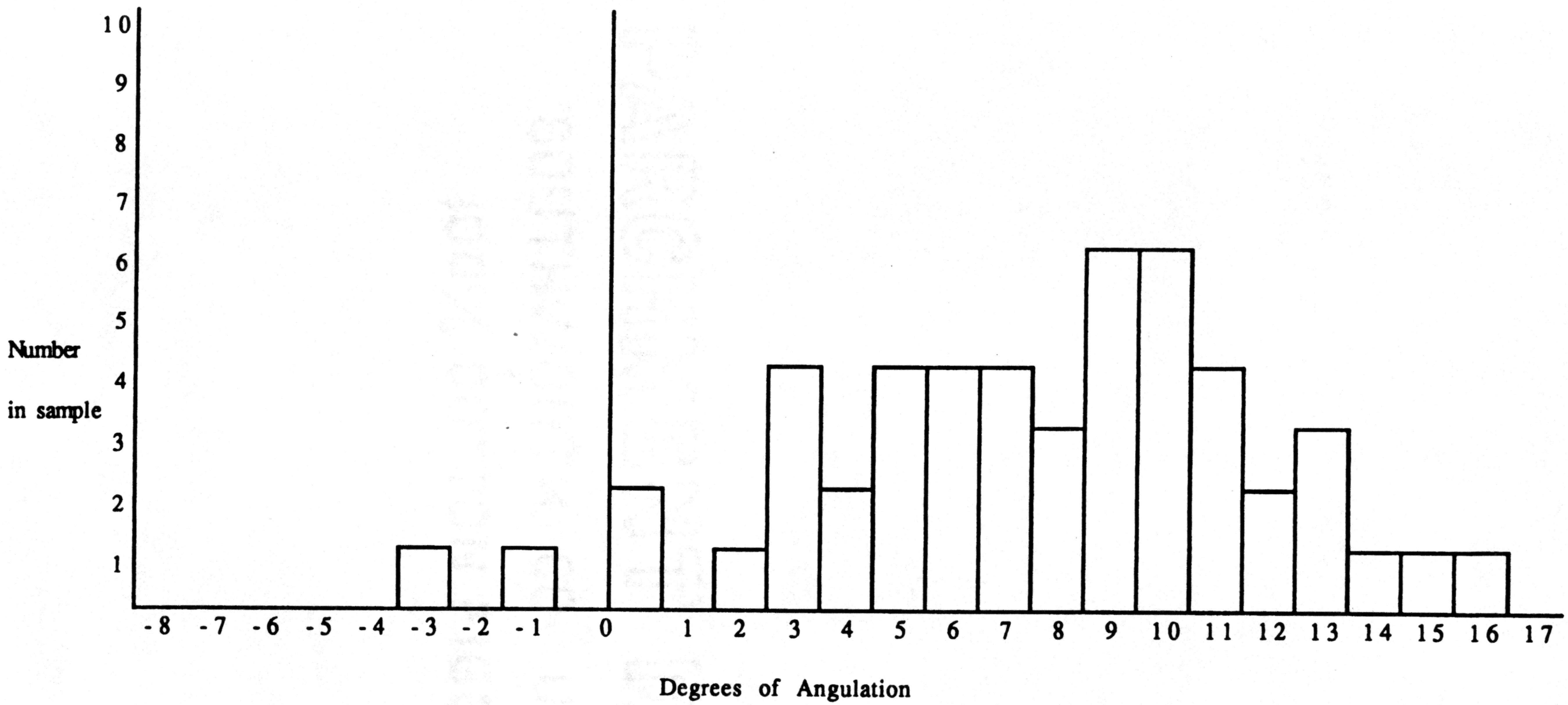

Fig. 2. Maxillary First Bicuspid Root Restoration

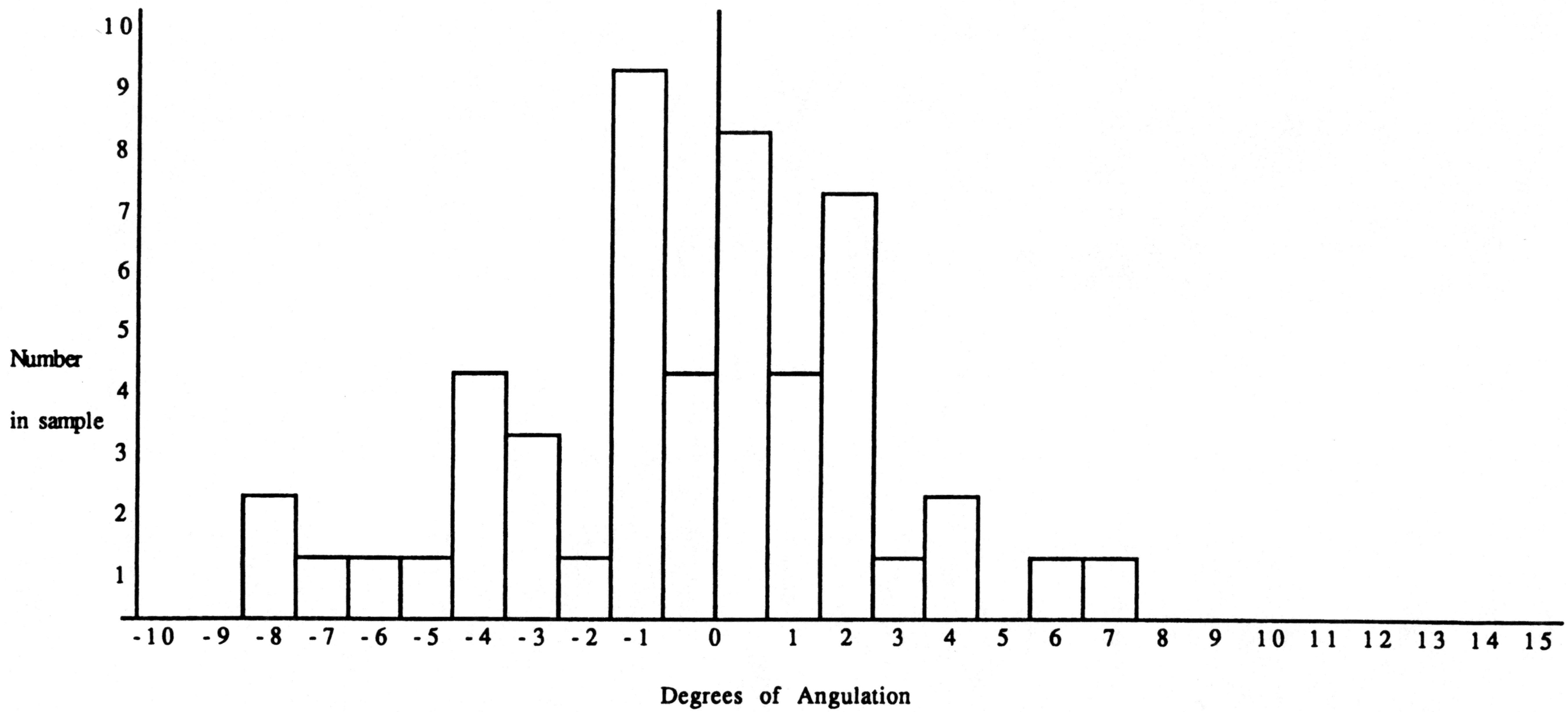

Fig. 1. Maxillary First Bicuspid Crown Distribution

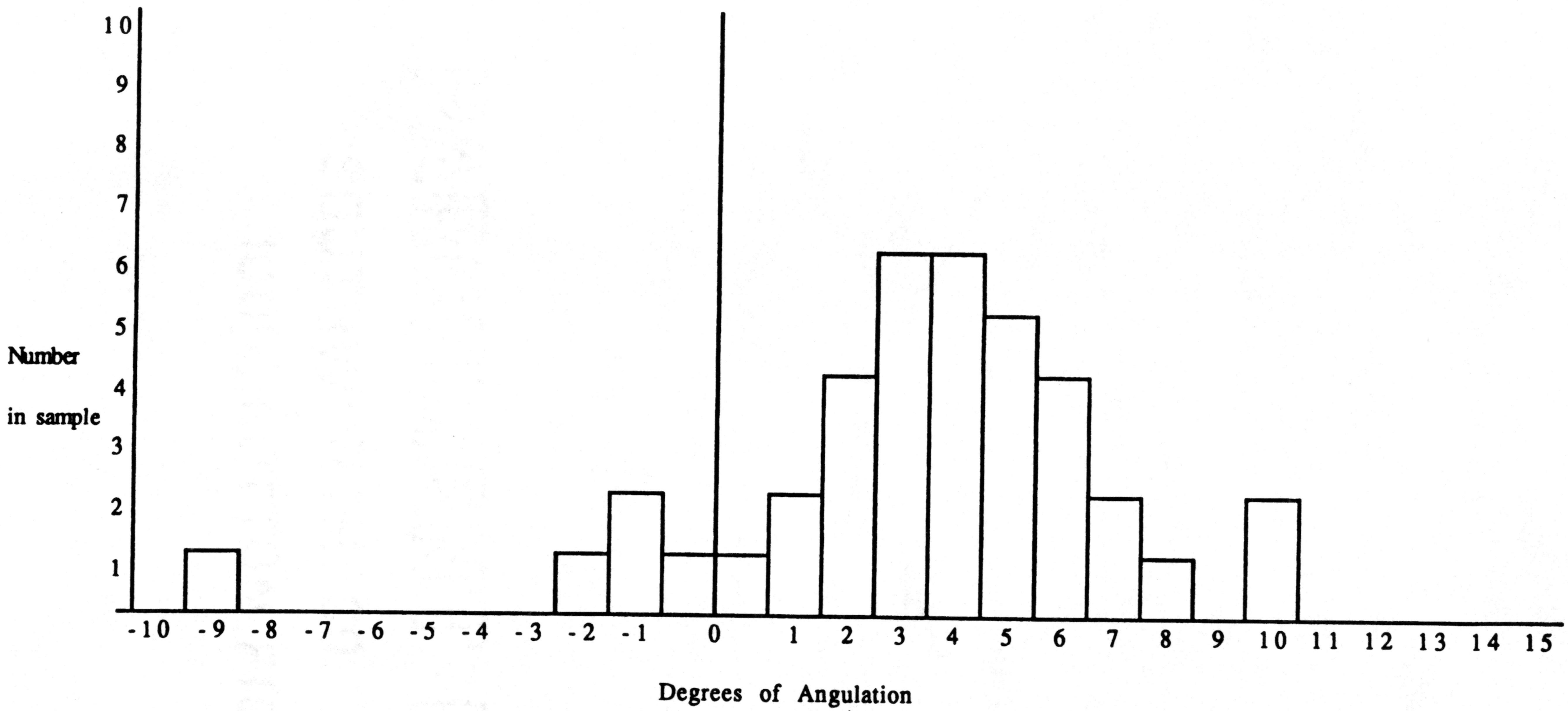

Fig. 3. Maxillary Second Bicuspid Crown Distribution

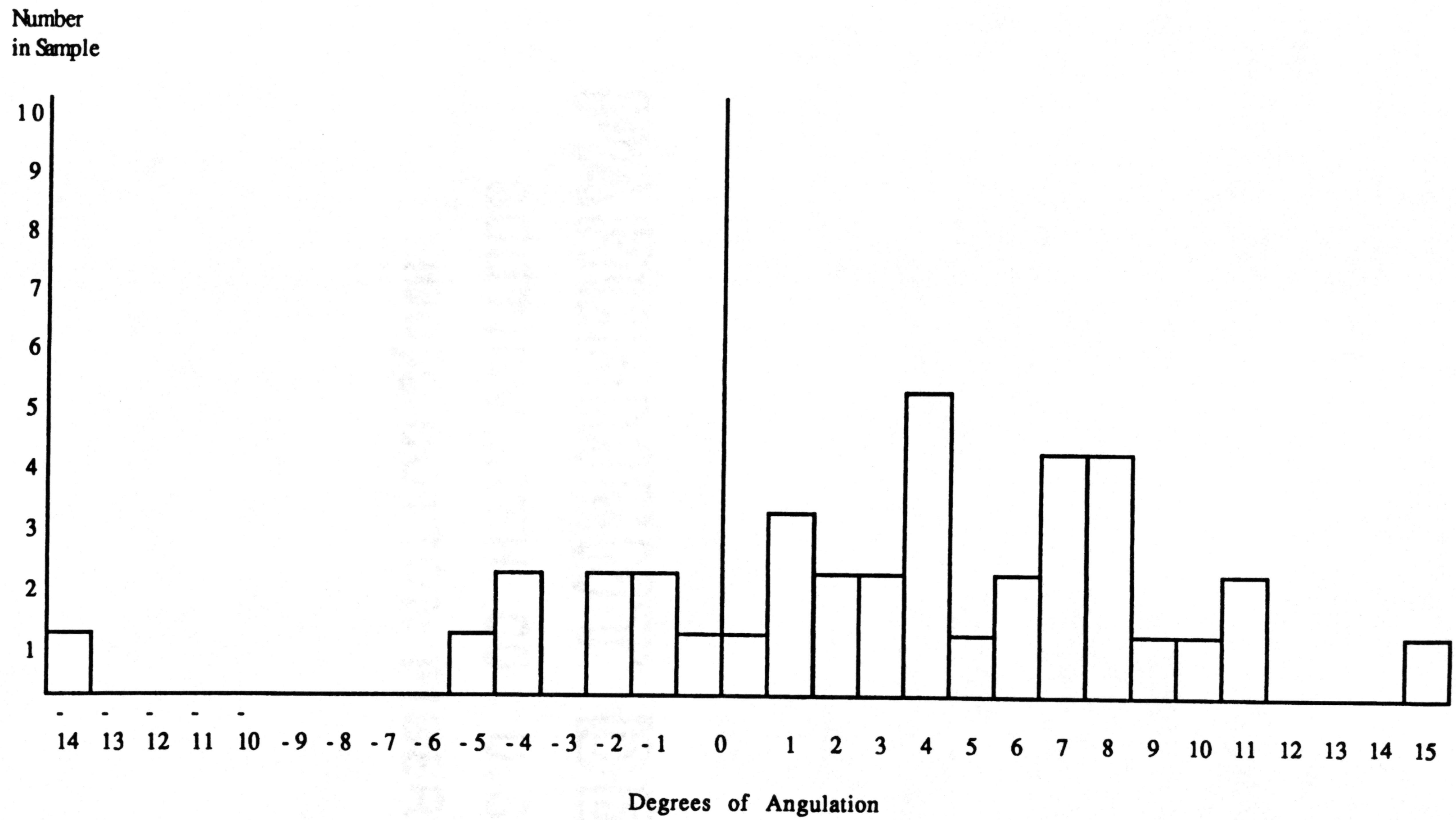

Fig. 4. Maxillary Second Bicuspid Root Distribution

Table 2.

Maxillary First Bicuspid Crown and Root Angular Measurements

Sample n=38	Crown Positive Measurements = Positive Anulation	Root Positive Measurement = Distal Angualtion
1	+1.45	+8.20
2	-1.16	+13.67
3	-1.07	+4.33
4	+2.38	+8.13
5	-4.67	+2.40
6	+0.53	+7.50
7	-0.25	+10.73
8	+2.27	+14.95
9	-5.30	+10.78
10	+4.03	+9.82
11	-2.15	+3.73
12	+6.45	+11.23
13	-1.73	+12.47
14	+2.53	+6.23
15	+0.73	+10.42
16	+2.77	+9.55
17	+1.87	+9.00
18	+2.53	+12.58
19	-1.80	+11.05
20	-1.57	+10.70
21	-1.53	+7.82
22	+1.00	+11.94
23	-8.30	+6.62
24	+0.50	+6.93
25	+0.87	+9.70
26	-1.00	+13.07
27	-0.27	+5.80
28	-4.88	+7.93
29	+0.20	+7.27
30	+0.37	+5.62

Continue Table 2.

Sample n=50	Crown Positive Measurement= Positive Angualtion	Root Positive Measurement= Distal Angualtion
31	-0.50	+13.88
32	+0.91	+5.77
33	-3.07	+6.45
34	+4.33	+15.44
35	-7.20	+0.39
36	-1.92	+3.07
37	+2.47	+10.95
38	+7.43	+16.12
39	+3.82	+9.45
40	-0.12	+11.80
41	_4.20	+3.33
42	-4.20	-3.97
43	-6.42	-1.35
44	+0.53	+10.24
45	-1.12	+5.18
46	-3.70	+3.07
47	-8.22	+0.67
48	+2.10	+8.45
49	+1.20	+4.82
50	-3.07	+9.90

Table 3.

Maxillary Second Bicuspid Crown and Root Angular Measurements

Sample n=38	Crown Positive Measurements = Positive Anulation	Root Positive Measurement = Distal Angualtion
1	+5.60	-0.32
2	+7.08	+7.28
3	+6.15	+6.08
4	+5.27	+7.24
5	+3.60	+3.60
6	+6.35	+4.15
7	-10.27	-14.90
8	+1.92	+4.75
9	+2.73	-2.87
10	+6.83	+9.36
11	+1.27	-4.83
12	+3.43	+15.62
13	+8.18	+4.58
14	+4.57	+7.22
15	+4.67	+11.42
16	+5.00	+4.05
17	+4.93	+11.06
18	+3.35	+6.00
19	+4.60	+2.42
20	+0.28	+8.47
21	-1.76	-1.18
22	+3.55	+4.58
23	+6.28	+8.12
24	+4.42	+8.15
25	+2.77	+1.90
26	-1.25	+2.12
27	+5.20	+10.88
28	+2.42	+3.77
29	+10.00	+7.45
30	+3.10	+1.98

Continue Table 3

Sample n=38	Crown Positive Measurement= Positive Angualtion	Root Positive Measurement= Distal Angualtion
31	-2.92	+0.45
32	-0.22	-2.60
33	+3.77	-5.05
34	+4.35	-4.40
35	+2.48	-1.53
36	+10.52	+5.42
37	+5.43	+1.02
38	+7.07	+8.63