Estimation Of The Sizes Of Unerupted Cuspid And Bicuspid Teeth

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A survey of the orthodontic literature for the last few years indicates increased interest in beginning orthodontic treatment during the period of the mixed dentition. The trend toward earlier treatment reflects better comprehension of malocclusions and their diagnosis. In terms of treatment, Kloehn's[1] revival of extraoral anchorage and Kjelgren's[2] introduction of serial extraction exemplify better understanding of the strengths and limitations of current appliance therapy. Some of the concepts underlying these therapies are: 1) relative stability of arch width in the untreated case after the eruption of the permanent incisors, 2) slight decrease in mandibular arch length anterior to the permanent molars, 3) inability of appliance therapy to measurably influence more than the teeth and their immediate supporting tissues, and 4) undesirable effects from extensive use of mandibular anchorage. In a recent paper, Weber[3] provided an excellent review of the concepts of mixed dentition diagnosis and treatment.

As pointed out by Nance[4], diagnosis during the mixed dentition hinges to a large extent on analysis of the lower arch. From this viewpoint, diagnostic variables to be considered are: 1) crowding or spacing present in the mandibular arch in the mixed dentition, 2) difference between the size of unerupted cuspids and bicuspids and space in the mandibular arch available for them, 3) inclination of the incisors, 4) expected slight increase in arch width, and 5) the expected slight decrease in arch length anterior to the permanent molars. Of the five considerations listed, perhaps the first two show the greatest variability and, as a result, receive the most attention in diagnosis and treatment planning.

Nance[4], Ballard & Wylie[5], Carey[6], and Griewe[7] have previously given consideration to the problem of predicting the size of the mandibular cuspids and bicuspids before their eruption and have developed useful techniques for this purpose. The primary objective of this investigation was to determine if a more efficient procedure could be found, i.e., if error in prediction could be reduced further. A byproduct, pertinent to analysis of the mixed dentition, was study of the relationship between size of the permanent cuspids and bicuspids and size of their deciduous predecessors.

The efficiency of the twelve procedures in predicting the size of teeth 3, 4, and 5 was explored by correlating the combined width of 3, 4 and 5 with the variables listed in Table I. To evaluate this series of relationships it was necessary to collect material for each subject which met the following requirements:*

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(1) A cast of the lower arch with c, d, and e present, and free from proximal carious lesions or restorations on one side of the arch.

(2) Periapical x-ray film of the same side as above, taken the same date as the impression for the cast, with c, d, and e present and erupted; with 3, 4, and 5 present but unerupted.

(3) A later cast with 3, 4, 5 and 2, 1, 1, 2 erupted; with no proximal carious lesions or restorations on the side measured previously.

A sample of forty one children, fifteen males and twenty-six females, from the Facial Growth Study at the State University of Iowa met the above requirements. All were American-born and of predominantly northwest European ancestry. The teeth were measured on hydrocal casts obtained from alginate impressions. The intraoral x-ray films used were taken by a technician using a conventional dental x-ray machine fitted with a cone giving a 16 inch skin-target distance.

The cast measurements of the mesial-distal diameter of the deciduous teeth and the x-ray measurements of c, d, e, and 3, 4, 5 were made within one year of the shedding of c, d, and e. The age range for these measurements was from 7 years, 6 months to 11 years. Tooth measurements of the permanent teeth of the same individuals were obtained from casts taken between 12 and 15 years of age.

*The following method of designating the mandibular teeth will be used throughout this paper:

1—permanent central incisor
2—permanent lateral incisor
3—permanent cuspid
4—1st bicuspid
5—2nd bicuspid
c—deciduous cuspid
d—deciduous 1st molar
e—deciduous 2nd molar
Width = maximum mesial-distal diameter

TABLE I

Correlations between the combined widths of erupted 3, 4, and 5 and the combined widths of several combinations of cast, film, or cast and film measurements. N = 41 unless otherwise noted.

Combined widths of 3, 4, and 5 correlated with:	*r*
c, d, e cast	.56
1, 2, 2, 1 cast	.69
3, 5 x-ray film	.78
4, 5 x-ray film	.80
3, 4 x-ray film	.82
3, 4, 5 x-ray film	.82
1, 2, 2, 1 cast plus c, d, e cast	.75
3, 4 x-ray film plus 1, 2, 2, 1 cast	.84
3, 4, 5 x-ray film plus 1, 2, 2, 1 cast plus c, d, e cast	.85
4, 5 x-ray film plus 1, 2, 2, 1 cast	.88
4, 5 x-ray film plus 1, 2 cast	.88*
4, 5 x-ray film plus 1, 2 cast	.87**
4, 5 x-ray film plus 1, 2 cast	.82***

*The multiple correlation (R) using 3, 4, 5 cast as the dependent variable, with 4, 5 (x-ray) and 1, 2 (cast) as the independent variables, is .88.

**N = 76, films taken between 7½ years and 11 years of age.

***N = 76, all films taken at 8 years of age except two taken at 7½ years.

For all teeth the maximum mesial-distal diameters of the crowns of the individual teeth were measured at right angles to the long axis of the tooth. A finely pointed, standardized Boley gauge was used throughout. Where teeth were rotated before eruption, the maximum crown diameter on the films measured at right angles to the long axis was considered as the width of these teeth.

Two independent measures were recorded for each tooth. If the two measures agreed within 0.1 mm, the average of the two was used. If disagreement exceeded 0.1 mm, two more independent measures were taken and the four averaged. Product-moment correlation coefficients of $r = .97$ and $r = .99$ indicate the high reliability of the two original cast and film measurements.

Associations for the combined widths of 3, 4, and 5, and each of twelve predictive combinations were obtained by preparing scattergrams and computing Pearson product-moment correlation co-efficients (r). The obtained values are given in Table I. One additional approach, an attempt to correct for enlargement of 3, 4, and 5 on the film by the ratio $\frac{\text{cast c, d, e}}{\text{x-ray c, d, e}}$ gave such wide dispersion on the scattergram that the correlation coefficient was not computed. Surprisingly, of the other relationships studied, the weakest was that between the size of the deciduous posteriors c, d, and e, and 3, 4, and 5 (r = .56). The relationship (r= .69) between the lower permanent incisors and 3, 4, and 5 is in close agreement with that reported by Ballard and Wylie[5], and by Griewe[7]. The strongest relationship found (r = .88) is that between the cast widths 1 and 2 plus the film widths of 4 and 5 correlated with 3, 4, and 5 when they had erupted. A stronger relationship could not be demonstrated by use of multiple correlation.

The width of 1 and 2 plus the x-ray measure of 4 and 5 gave a sufficiently strong relationship to be clinically useful in predicting the size of 3, 4, and 5 before their eruption. Since this relationship does not involve the size of c, d, and e, the restriction in sample selection with reference to restorations in the deciduous teeth could be removed. By removing this restriction an additional thirty-five subjects became available for study. The larger sample (N = 76) provided a better basis for generalizing in terms of clinical use. The coefficient of correlation from the seventy-six cases, utilizing the best film of 4 and 5 available before their eruption, was $r = .87$. This figure is included in Table I. In Table II, the results have been expanded for prediction purposes in clinical situations.

The standard error of estimate for this relationship is 0.57 mm., which means the size of 3, 4, and 5 can be predicted before their eruption within 0.57 mm. for two-thirds of the cases, and the error of prediction will not exceed 1.1 mm. on more than one child

TABLE II

A TECHNIQUE FOR ESTIMATION OF THE SIZES OF MANDIBULAR CUSPIDS AND BICUSPIDS

Sum the maximum mesial-distal diameters of one permanent mandibular central and one lateral incisor with the diameter of the unerupted first and second bicuspids measured on the intraoral film of the same side. Enter this figure as the measured value to estimate the sum of the widths of the cuspid and bicuspids.

This estimate should be accurate within 0.6 mm. for 68% of the cases, within 1.1 mm. for 95% of the cases, and within 1.7 mm. for 99% of the cases.

Note: These data are valid only when a 16 inch cone is used on the dental x-ray machine.

measured value	estimated tooth size
23 mm.	18.4 mm.
24	19.0
25	19.7
26	20.3
27	21.0
28	21.6
29	22.3
30	22.9

N = 76
M (x) = 20.96 mm.
S.D. (x) = 1.14
M (y) = 26.98
S.D. (y) = 1.53
r (xy) = .868
X = .6474Y + 3.493
S.E. est. = .568

in twenty. The error of prediction will be as great as 1.7 mm. one time in 100. The index of forecasting efficiency[8] is 50 per cent. This represents an improvement of more than 25 per cent over methods previously suggested.

For the sample under study the maximum error of prediction from the proposed technique was 1.2 mm. Corresponding maximum errors were 2.8 mm. with the Carey chart, 2.3 mm. with the Ballard & Wylie chart, and 3.9 mm. from x-ray measurements of 3, 4, and 5 only.

Recommendation of this technique presupposes the use of a cone on the dental x-ray machine which gives a 16 inch skin-target distance. We have no information regarding relationships when using other cones. We obtained findings from use of films taken at eight years of age, irrespective of their quality, except for two individuals in whom the cuspids were erupting early. For these two, films taken at seven and one half years were used. The correlation coefficient, as shown in Table I, is $r = .82$. This would indicate slightly less efficiency in predicting from films taken at the younger ages, especially when possibility of retakes of poor films is excluded.

In mixed dentition analysis, the estimated size of 3, 4, and 5 can then be compared with the space available for their eruption. This space available can be obtained by measuring from the mesial surface of the mandibular permanent molars to the distal of the lateral incisors with a Boley gauge on which the measuring blades have been ground to a fine edge. For alignment of the teeth, compensation must then be made for incisor crowding or spacing, improper incisor inclination, plus incisal rotations. In ascertaining space for alignment, the potential mesial shift of the molars should also be considered.

Table III presents singly, and in combination, the difference in tooth size found between c, d, and e, and their permanent successors. Clinically, the most significant figures are the values obtained for the difference in size between the combined widths of c, d, and e, and 3, 4, and 5. On the average, the combined width of the three permanent teeth was 2.1 mm. smaller than that of the three deciduous teeth.

Carey[5] has pointed out the wide individual variation that exists between these deciduous and permanent teeth. This is consistent with the correlation coefficient ($r = .56$) noted in Table I, as well as the 1.1 mm. standard deviation seen in Table III. The range of this difference extended from 0.1 mm. in one case to 4.4 mm. for another child.

This is equivalent to some children

TABLE III

Analysis of the difference between the mesial-distal widths of 3, 4, and 5 minus the mesial-distal widths of c, d, and e in the mandibular arch, for 41 cases.

Tooth Widths	*Mean*	*S.D.*	*Range*
3 - c	+ 1.01 mm.	.39 mm.	+ .2 to + 2.0 mm.
4 - d	— .60 mm.	.48 mm.	+ .4 to — 1.6 mm.
5 - e	— 2.55 mm.	.42 mm.	— 1.7 to — 3.3 mm.
3, 4, 5 - c, d, e	— 2.13 mm.	1.05 mm.*	— .1 to — 4.4 mm

*Standard error of standard deviation is 0.11 mm.

showing no change in tooth size during the transition from the mixed to permanent dentition, while others show almost a 9 mm. decrease in tooth structure from the mesial surface of one first permanent molar around to the mesial surface of the opposite mandibular molar. Such a difference between the size of c, d, and e and 3, 4, and 5 is of clinical importance as some cases of extreme crowding in the mixed dentition in which serial extraction seems indicated will ultimately have sufficient room for alignment of the incisors plus space for 3, 4, and 5. Thus, the proposed predictive chart constitutes an improved aid in identifying such cases. The predictive chart is, of course, useful in mixed dentition analysis whenever c, d, or e has been prematurely lost.

Summary

1) The sizes of the mandibular cuspid and bicuspids were studied in relation to several variables.

2) From these relationships, it was possible to select a better technique for estimating the size of these teeth before their eruption. This involves measuring a mandibular permanent central and lateral plus the sizes of the x-ray images of the two unerupted bicuspids on the same side using a 16 inch cone on the x-ray machine. The index of forecasting efficiency for this technique shows a 25% improvement over previously suggested methods.

3) The variability found between the combined widths of the deciduous molars and cuspid and their permanent successors ranged from 0.1 mm. to 4.4 mm. The standard deviation of this difference in size between the two groups of teeth is decidedly greater than the standard error of estimate of the technique proposed for estimating the sizes of the unerupted cuspid and bicuspids.

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