Increase In Intraoral Height Of Selected Permanent Teeth During The Quadrennium Following Gingival Emergence *

NORMAN B. GILES, D.D.S., M.S., VIRGINIA B. KNOTT, Ph.D. and HOWARD V. MEREDITH, Ph.D.

Iowa City, Iowa

The ontogeny of a tooth may be described in terms of changes in its size, shape, position, and composition.[11] This study pertains to ontogenetic change in tooth position.

There are several varieties of change in tooth position. These include movements anteroposteriorly,[4] transversely,[9] and vertically.[2] Movement that is largely vertical and in the direction of the occlusal plane is referred to either as eruption or active eruption.[5] The present study concentrates on one segment of the course of tooth eruption, that segment beginning at the time of gingival emergence for a given tooth and extending over the succeeding four years.

Six permanent teeth on the left side of the dental arches are investigated, the upper and lower central incisors, upper and lower canines, and upper and lower second premolars. The measure of movement utilized is intraoral tooth height. Although this height principally represents tooth movement in the odontologic periods under consideration, it should be recognized that intraoral tooth height is sometimes slightly augmented through gingival recession or reduced by tooth wear at the incisal or occlusal surface.

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OBJECTIVES

Specific aims of the study are:

1. To determine, for each of six permanent teeth, the mean trend of increase in intraoral crown height during the first four-year period succeeding gingival tooth emergence. Also, to determine whether every individual trend follows a course similar to that of the mean trend.

2. To describe, for the same six teeth, the variability of intraoral crown height at each of five selected points in the quadrennium following gingival tooth emergence.

3. To present central tendency and variability analyses showing the times children take to erupt different percentages of the maximum intraoral heights their permanent teeth attain within four years after piercing the alveolar mucosa.

4. To derive an eruption reference chart and indicate its clinical usefulness to the pedodontist and orthodontist.

EARLIER STUDIES

Research pertaining solely or in part to vertical movement of permanent teeth subsequent to gingival emergence has been reported by Burke and Newell,[1] Carlson,[2] Cattell,[3] Hellman,[8] Hargreaves,[7] and Shumaker and Hadary.[12]

In 1928, Cattell[3] published preliminary findings based partly on cross-sectional data and partly on longitudinal

data. Direct oral observations were made on children attending schools in the vicinity of Boston. The following tripartite classification was used: a tooth was rated 1 from gingival emergence to "one-third the way to occlusion," 2 between one-third and two-thirds the way to occlusion, and 3 "from two-thirds . . . to full occlusion." For the permanent maxillary central incisor tooth, it was estimated that the median time taken in passing from stage 1 to stage 2 (2.9 months) was much less than that between stages 2 and 3 (6.1 months). It also was noted that a permanent tooth may pass from stage 1 to stage 3 in less than three months for one child, while taking more than eighteen months for another.

Hellman,[6] in 1930, studied the permanent canine, first and second premolar, and second molar teeth in respect to the time transpiring from when each tooth "just pierced the gum" to when it "reached the level of occlusal contact." The subjects were New York children seen in private orthodontic practice, "a large number of whom were not under treatment, just under observation." Examinations were made at monthly intervals. Statistics reported on mean time occupied in intraoral eruption include the following: for the maxillary canine, 13.9 months from seventy children; for the mandibular canine, 11.4 months from forty-two children; for the maxillary second premolar, 6.7 months from sixty-one children; and for the mandibular second premolar, 7.5 months from fifty-nine children. Standard deviations are interpreted to indicate individual variation in the time consumed by "the natural process" of active intraoral eruption.

An investigation of the upward movement of mandibular teeth was reported in 1944 by Carlson.[2] The source materials were serial cephalometric roentgenograms for five children with "normal occlusion" of the dental arches. From a line "tangent to the inferior border of the mandible," distances were measured to the most superior point on each of five permanent mandibular teeth. It was concluded: (a) during the period of crown formation there is little movement vertically, (b) rapid vertical movement occurs after the crown is fully formed and continues until the tooth comes into occlusion, and (c) when occlusion is reached there is an abrupt slowing of vertical movement.

Burke and Newell,[1] in 1958, published an intensive study of one child in regard to intraoral eruption of the permanent maxillary incisor teeth. Standardized intraoral photographs were obtained "daily . . . covering a period of about one year." The subject was a girl 7.4 years of age when gingival emergence of the maxillary incisors began. All four curves for tooth movement in the direction of the occlusal plane were found to be "smooth with a gradually decreasing gradient." More explicitly, intraoral migration of the maxillary incisor teeth in the occlusal direction proceeded at a declining rate with time, showing "no long periods of rest or gross rhythmic variations."

For each of 157 permanent teeth observed in sixty-four European children, Hargreaves[7] determined "time from the first emergence of portions of a crown of a tooth into the mouth to its attaining full function by contacting its antagonist on closure." Observations were made for all permanent teeth except the first molars. In view of the paucity of data for any one tooth, certain composite means are given in this 1958 report. These mean intraoral eruption times include the following: "nine weeks" for the four maxillary incisor teeth, "seven weeks" for the four mandibular incisor teeth, "sixteen weeks" for the mandibular canine teeth, and

"eleven weeks" for the mandibular second premolar teeth.

Shumaker and Hadary,[12] in 1960, reported a study of vertical movement from the stage of complete crown calcification to that of full occlusion for five permanent mandibular teeth. Their materials were "right lateral jaw roentgenograms" obtained annually on fifty-seven children attending the University of Michigan Elementary School. For each tooth the minimum distance between the superior point of the crown and the inferior border of the mandible was expressed as a percentage of the sum of this distance and the minimum distance from the superior point of the crown to an occlusal line. Successive percentages from the serial roentgenograms indicated vertical tooth movement. It was found: (a) each tooth commences to move toward occlusion near the time of crown completion, and (b) the time from crown completion to "occlusion" approximates 4.5 years for the right mandibular canine tooth and 5.0 years for the right second premolar tooth.

Subjects

The subjects were seventy-five North American white children residing in or near Iowa City, Iowa. All were voluntary participants in a longitudinal research program begun in 1946 at the State University of Iowa. Enrollment for study was determined by likelihood of continuing residence in the community and willingness to cooperate; no criterion of selection pertained to orthodontic or other dental condition.

Data and Methods

The original data are measurements of intraoral height for six teeth of the permanent dentition on the left side of the dental arches; namely, maxillary and mandibular central incisors, canines, and second premolars. For each tooth, these data extend over a four-year period following gingival emergence.

The measurements were taken on hydrocal casts made from alginate-base hydrocolloid molds. Casts were available at semiannual intervals until at least twelve years of age, and at annual intervals thereafter. The impressions had been obtained within a few days of each subject's birth anniversary and mid-anniversary dates.

In taking material from the files, the initial step was to draw series of dental casts for fifty males on whom the upper and lower permanent left central incisors could be studied from the time of gingival emergence throughout the succeeding quadrennium. All findings in respect to the movement of incisor teeth will be based on this male sample.

Casts for study of permanent canine and second premolar teeth were drawn similarly. Using the criterion of serial material available over a period of no less than four years subsequent to gingival emergence, there were casts for the upper and lower left canines on twenty-two males and for the upper and lower left second premolars on eighteen males. In order to increase sample size, all available quadrennial series on females were added. This gave samples of forty-two children for the canine teeth and thirty-three children for the second premolar teeth. It will be shown later that in the present investigation on intraoral movement of these teeth combination of the sexes is tenable.

Measurements were taken in lines approximately parallel with the gross plane of the labial surface of incisor teeth and the buccal surface of canine and second premolar teeth. Rectilinear distances were measured: (a) from the midpoint of the incisal edge of each left central incisor tooth to the midpoint of the labial surface at the level of the

gingival crest, (b) from the cusp tip of each left canine tooth to the point at the level of the gingival crest in a buccolingual plane passing through the cusp tip, and (c) from the tip of the buccal cusp of each left second premolar tooth to the point at the gingival crest in a buccolingual plane through the tip of this cusp.

The measuring instrument was Glogau's Vernier Calipers, Number 12. This was modified by cutting the sliding arm 4.0 mm shorter than the fixed arm and grinding it thin and narrow for placement at the gingival crest. The retained thickness of the sliding arm introduced a systematic error that was corrected by adding 0.2 mm to every measurement.

Intraoral height of each tooth was measured to the nearest 0.1 mm by two trained measurers working independently. Approximately 90 per cent of the paired records obtained were in agreement within 0.2 mm. Wherever there was greater discrepancy, both workers made additional independent measurements. The values used in ensuing analyses are (a) means of paired records not differing more than 0.2 mm and (b) means of several records, after elimination of obvious misreadings of the instrument scale.

Age of gingival emergence for each of the 250 teeth under study had been determined before the present investigation was planned. A description of the procedure used in amassing these data is available elsewhere.[14] Suffice to note here that the data represent estimated "age at which the alveolar mucosa is pierced and intraoral exposure of the tooth approximates 1.0 mm in diameter."

Two hundred and fifty graphs were plotted to depict the intraoral movement of every tooth separately. Age of gingival emergence was used as the initial or zero value on the time scale (abscissa) and the consecutive height measures on a given tooth as ordinate values. After drawing a point-to-point line portraying change in intraoral tooth height with time, each individual curve was utilized for two purposes:

1. To obtain comparable readings for amount of intraoral tooth height at five specified times after gingival emergence. The times selected were gingival emergence plus 6 months, 1 year, 2 years, 3 years, and 4 years.

2. To determine the time taken in erupting different percentages of the maximum intraoral height attained during the quadrennium following gingival emergence. The four time periods ascertained were those in which a given tooth erupted 50 per cent, 70 per cent, 90 per cent, and 100 per cent of its greatest intraoral height in the first four years after piercing the alveolar mucosa.

Intraoral Tooth Height in the Quadrennium Succeeding Gingival Emergence

Table I presents central tendency and variability findings for intraoral height of the permanent maxillary and mandibular left central incisor teeth at five different times after gingival emergence. Each row of this table is based on the same sample of fifty males. Table II and III carry similar analyses for the permanent left canine and second premolar teeth. Before the latter tables were compiled, statistical tests were made as an aid in judging the reasonableness of pooling the male and female data accessible for these teeth. From none of the four canine and second premolar teeth was the observed difference between intraoral height means on the two sexes greater than 0.5 mm. The largest t ratio obtained (1.68, d.f. 31) was less than that required (2.04, d.f. 31) for rejecting the null hypothesis at the 5 per cent level

TABLE I

Intraoral height (mm) of permanent central incisor teeth at different times after gingival emergence

Years After Gingival Emergence	N*	Mean	S.D.**	Minimum	Percentiles:				Maximum
					10	30	70	90	
Infragingival Height of Upper Left Tooth									
0.5	50	6.44	0.84	4.8	5.4	5.9	6.9	7.6	8.3
1.0		7.70	1.04	6.0	6.3	7.0	8.1	9.0	10.3
2.0		8.62	1.21	6.6	7.1	7.8	9.2	10.4	11.3
3.0		8.95	1.11	7.1	7.5	8.4	9.5	10.6	11.4
4.0		9.15	1.06	7.2	7.9	8.6	9.6	10.5	12.0
Supragingival Height of Lower Left Tooth									
0.5	50	4.90	0.77	3.1	3.9	4.5	5.3	6.0	6.6
1.0		6.07	0.79	4.3	5.1	5.7	6.4	7.1	7.9
2.0		7.06	0.95	5.4	5.7	6.6	7.6	8.4	9.0
3.0		7.40	0.87	5.7	6.2	7.0	8.0	8.6	9.1
4.0		7.57	0.88	5.7	6.3	7.2	8.0	8.6	9.2

*Fifty white males studied longitudinally.
**Estimate of population standard deviation (see Guilford,[6] p. 184).

TABLE II

Intraoral height (mm) of permanent canine teeth at different times after gingival emergence

Years After Gingival Emergence	N*	Mean	S.D.	Minimum	Percentiles:				Maximum
					10	30	70	90	
Infragingival Height of Upper Left Tooth									
0.5	42	6.25	0.87	4.5	5.1	5.7	6.8	7.4	8.3
1.0		7.71	0.79	6.1	6.6	7.3	8.2	8.9	9.2
2.0		8.40	0.78	6.9	7.3	8.0	8.9	9.5	10.0
3.0		8.59	0.83	7.1	7.4	8.2	9.1	9.8	10.0
4.0		8.76	0.92	7.2	7.4	8.2	9.3	10.0	10.7
Supragingival Height of Lower Left Tooth									
0.5	42	5.64	0.78	4.0	4.4	5.2	6.0	6.6	7.2
1.0		7.14	0.79	5.5	6.2	6.7	7.5	8.4	8.6
2.0		8.02	0.68	6.9	7.1	7.6	8.3	9.1	9.5
3.0		8.38	0.74	7.1	7.4	8.0	8.8	9.4	9.8
4.0		8.68	0.80	7.2	7.6	8.3	9.0	9.8	10.5

*Twenty-two white males and twenty white females studied longitudinally.

TABLE III

Intraoral height (mm) of permanent second premolar teeth at different times after gingival emergence

Years After Gingival Emergence	N*	Mean	S.D.	Minimum	Percentiles: 10	30	70	90	Maximum
Infragingival Height of Upper Left Tooth									
0.5	33	4.83	0.64	3.7	4.0	4.4	5.3	5.6	6.3
1.0		5.34	0.55	4.6	4.7	4.9	5.6	6.3	6.5
2.0		5.67	0.60	4.7	4.9	5.3	5.8	6.6	6.7
3.0		5.82	0.61	4.7	5.0	5.5	6.1	6.7	6.9
4.0		5.97	0.67	4.6	5.1	5.6	6.4	6.8	7.3
Supragingival Height of Lower Left Tooth									
0.5	33	5.40	0.61	4.2	4.6	5.0	5.8	6.2	6.5
1.0		5.99	0.46	5.2	5.4	5.7	6.2	6.6	6.9
2.0		6.43	0.50	5.2	5.9	6.1	6.6	7.0	7.6
3.0		6.60	0.48	5.5	6.1	6.3	6.8	7.1	7.7
4.0		6.74	0.51	6.0	6.1	6.4	7.0	7.3	8.3

*Eighteen white males and fifteen white females studied longitudinally.

of confidence. With this underpinning, the analyses in Table II and III were made disregarding sex.

The six series of means from Table I to III were used to draw the mean trends depicted in Figure 1. On joint consideration of the means, the mean trends, and the results from appropriate statistical tests[10] for differences in means for corresponding teeth of the two dental arches, it is found:

1. Each of the six teeth studied yields a mean trend that may be characterized as an ascending curve markedly concave to the chronologic base line. This finding confirms and extends the previous research of Cattell[3] and Burke and Newell.[1] Generalizing, intraoral eruption proceeds at a progressively slowing average rate during the early years after gingival emergence.

2. Amount of intraoral tooth eruption during the first six months following gingival emergence differs (P >

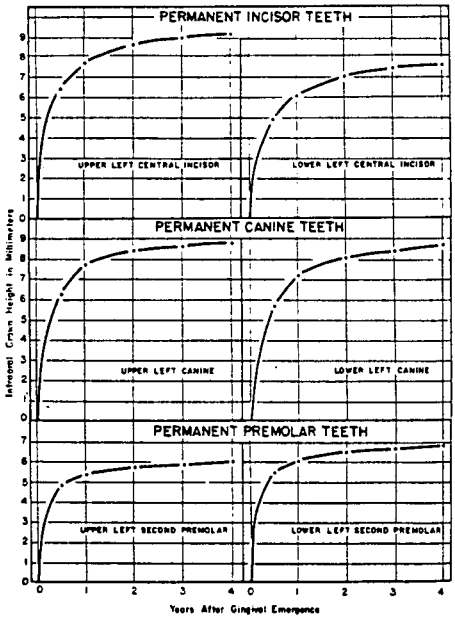

Figure 1. Mean trends of increase in intraoral height for six permanent teeth. The paired values in columns 1 and 3 of Tables I to III were used as coordinates.

0.01) for the maxillary central incisor and the mandibular central incisor. The obtained mean of 4.90 mm from the latter is 1.54 mm less than that from the former, and approximately the same systematic difference is maintained at the later times studied.

3. Infragingival height of the maxillary canine is greater than supragingival height of the mandibular canine at 6 months, 1 year, and 2 years after gingival emergence ($t > 2.80$ in each instance). Four years after gingival emergence these teeth are approximately alike in mean intraoral height.

4. The mean trends for the upper and lower second premolar teeth contrast with those for the upper and lower central incisor teeth in showing greater intraoral eruption in the lower arch than in the upper arch. These dental arch differences for the central incisors and second premolars are, at once, opposite in direction and alike in being statistically dependable at the 1 per cent level of confidence.

Columns 4 through 10 of Tables I to III describe the variability of subgrouped data for intraoral tooth height in terms of the standard deviation and selected percentiles. Inspection of these columns will confirm:

1. The spread of comparable frequency distributions for different teeth is least for the mandibular second premolar and greatest for the maxillary central incisor.

2. Distance between percentiles 30 and 70 varies from 0.5 mm to 0.9 mm in the fifteen distributions for second premolar and mandibular canine teeth. In the fifteen distributions for central incisor and maxillary canine teeth the limits including the central 40 per cent of the subjects differ by 0.7 mm to 1.4 mm.

3. On each of the six teeth investigated there is a relatively slight difference between the lower 70 per cent of the distributions at 3 years and 4 years subsequent to gingival emergence.

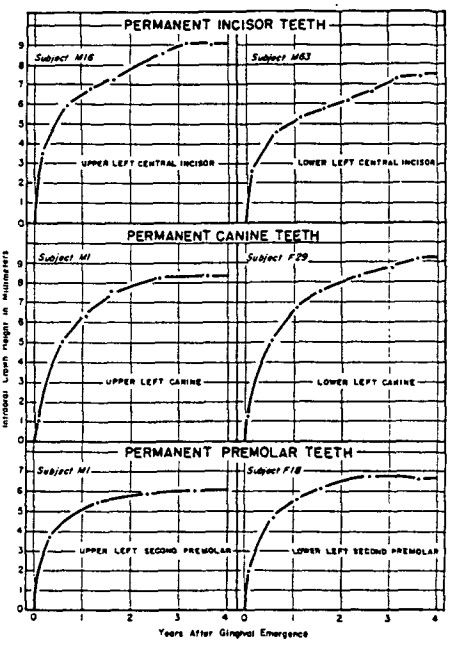

Figure 2. Individual curves of intraoral tooth height. For each of six permanent teeth the curve shown is the one exhibiting minimum curvature in the triennium following gingival emergence.

Besides considering variability at selected times after gingival emergence, it is pertinent to consider variation among curves for intraoral height of a given tooth on individuals. All of the individual curves, in common with the Figure 1 curves drawn to means, have an upward slope of rapidly diminishing steepness. There is variation to the extent that some of the curves in each series show greater concavity to the chronologic base line than others. Figure 2 portrays one selected curve from each series. The selections were made by limiting attention to the first triennium following gingival emergence and withdrawing from every series the curve exhibiting least curvilinearity.

TABLE IV

Time taken (mos.) erupting different relative amounts of maximum intraoral height attained by permanent incisor teeth in the first four years after gingival emergence.

Relative Intraoral Height %	N*	Median	Minimum	Percentiles: 10	30	70	90	Maximum
Maxillary Left Central Incisor								
50	50	3.0	2.2	2.5	2.7	3.4	4.5	5.8
70		5.9	3.1	3.6	4.9	7.0	8.2	11.4
90		18.4	8.4	10.4	15.2	22.3	27.9	34.6
100		43.8	22.0	27.2	38.8	48.0	48.0	48.0
Mandibular Left Central Incisor								
50	50	3.2	1.8	2.2	2.7	3.8	5.5	6.8
70		7.8	3.0	3.5	5.8	9.1	11.7	14.3
90		19.6	8.6	12.8	16.5	23.3	28.4	33.5
100		45.0	15.0	28.1	38.9	48.0	48.0	48.0

*Fifty white boys studied longitudinally.

TABLE V

Time taken (mos.) erupting different relative amounts of maximum intraoral height attained by permanent canine teeth in the first four years after gingival emergence.

Relative Intraoral Height %	N*	Median	Minimum	Percentiles: 10	30	70	90	Maximum
Maxillary Left Canine								
50	42	3.1	1.6	2.0	2.7	3.7	4.4	5.6
70		5.7	3.2	4.4	5.0	6.6	8.9	18.1
90		12.5	7.0	7.9	10.4	16.0	26.6	40.9
100		48.0	8.8	19.8	36.7	48.0	48.0	48.0
Mandibular Left Canine								
50	42	3.5	2.0	2.5	2.9	4.0	5.6	6.2
70		7.3	3.2	4.8	6.5	8.0	11.3	15.1
90		19.4	9.0	11.3	16.1	22.5	35.2	40.4
100		48.0	16.6	26.9	47.1	48.0	48.0	48.0

*Twenty-two white boys and twenty white girls studied longitudinally.

TABLE VI

Time taken (mos.) erupting different relative amounts of maximum intraoral height attained by permanent second premolar teeth in the first four years after gingival emergence.

Relative Intraoral Height %	N*	Median	Minimum	Percentiles: 10	30	70	90	Maximum
Maxillary Left Second Premolar								
50	33	2.4	1.6	1.7	2.0	2.6	3.1	4.8
70		3.6	2.4	2.8	3.4	4.3	5.6	11.0
90		13.8	3.8	5.3	8.2	15.5	24.5	34.8
100		48.0	10.6	22.6	40.0	48.0	48.0	48.0
Mandibular Left Second Premolar								
50	33	2.5	1.9	2.0	2.3	2.8	3.4	4.1
70		3.6	2.8	2.9	3.2	5.2	6.1	7.8
90		13.9	4.9	6.2	8.8	17.0	22.2	33.8
100		48.0	17.6	21.5	34.0	48.0	48.0	48.0

*Eighteen white males and fifteen white females studied longitudinally.

Time Taken to Erupt Selected Percentages of Intraoral Tooth Height

For the six permanent teeth under study, Tables IV, V, and VI give statistics pertaining to the time periods occupied in erupting different percentages of the maximum intraoral height attained in the quadrennium succeeding gingival eruption. Since the distributions are not symmetrical, the median is employed to indicate central tendency. Intercomparison of the tabled medians reveals:

1. Permanent central incisor and canine teeth typically take between 3.0 months and 3.5 months to erupt the first one-half of their respective intraoral heights. Permanent second premolar teeth reach the same stage in approximately 2.5 months. Application of the Mann-Whitney U Test[13] shows this relatively faster early intraoral movement of second premolar teeth to be significant statistically ($P < 0.01$).

2. Median length of time taken in erupting 70 per cent of maximum intraoral height reached in the first four years after gingival emergence is 3.6 months for the permanent second premolar teeth. Corresponding values approximate 6.0 months for the permanent maxillary canine and central incisor teeth, and 7.5 months for the permanent mandibular canine and central incisor teeth. Significance test results (Mann-Whitney, $P < 0.01$) permit the following generalization: On the average, 70 per cent of intraoral eruption is attained more rapidly by permanent second premolars in comparison with canines and central incisors, and by permanent maxillary canines and central incisors in comparison with their mandibular antagonists.

3. Typically, the time occupied in erupting 90 per cent of intraoral tooth height approximates 13 months for the

permanent maxillary canine and second premolar teeth, and 19 months for the permanent mandibular canine and central incisor teeth. Again in respect to differences dependable with 0.01 probability, it may be inferred that nine-tenths of intraoral eruption is completed in shorter average time for permanent second premolars than central incisors, and for permanent maxillary canines than mandibular canines.

Columns 4 through 9 of Tables IV to VI characterize variability in time taken to erupt selected percentages of maximum intraoral tooth height in the quadrennium following gingival emergence. It will be seen:

1. For each of the six permanent teeth studied, the minimum time in erupting the first one-half of intraoral height approximates 2.0 months. The 50 per cent level of intraoral migration is reached by all second premolar teeth in less than 5.0 months, and by all canine and central incisor teeth in less than 7.0 months.

2. Intraoral eruption of 70 per cent of the permanent lower second premolar requires no longer than 3.0 months for 1 child in 10, and slightly more than 6.0 months for 1 child in 10. With permanent lower canine and central incisor teeth, the corresponding time interval encompassing 8 children in 10 begins about 3.5 months following gingival emergence and terminates 8.0 months later.

3. Attainment of maximum intraoral height during the first four years following gingival emergence, for each permanent tooth studied, requires less than 30 months in 10 per cent of children and the full 48 months in 30 per cent of children. Always no less than 70 per cent of maximum intraoral tooth height is present by 18 months after gingival emergence, and no less than 90 per cent by 41 months after gingival emergence.

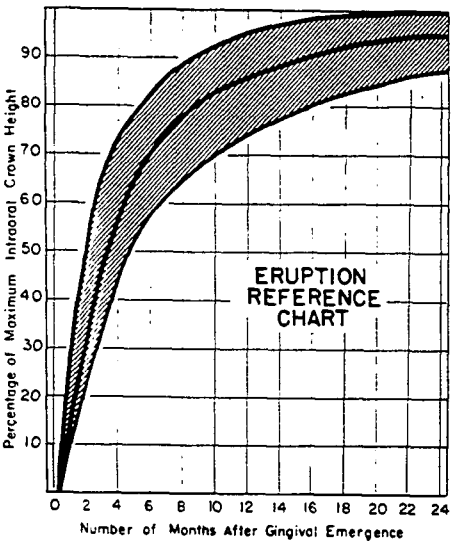

Figure 3. Generalized reference chart depicting times children may take in erupting different percentages of maximum intraoral height of permanent incisor, canine, and premolar teeth. Any horizontal line through the striped band gives the time limits for approximately 80 per cent of children.

The statistics from columns 3, 5, and 8 of Tables IV to VI were employed to derive the eruption reference chart shown in Figure 3. This chart may be viewed as a composite representation for permanent incisor, canine and premolar teeth, its three heavy lines depicting percentiles 10, 50, and 90 of distributions for time occupied in erupting different relative amounts of intraoral tooth height. The convenience of this single semischematic chart is gained at some loss of precision in respect to particular teeth. Orthodontists and pedodontists willing to make use of several charts, rather than a generalized one, are urged to construct from Tables IV to VI separate charts for (a) the upper and lower premolar teeth, (b) the upper and lower central incisor and lower canine teeth, and (c) the upper canine tooth.

Utilization of Figure 3 will be indicated by two illustrations:

1. Assume that child X exhibits a permanent upper central incisor just piercing the alveolar mucosa. When can this tooth be expected to reach 60 per cent of its full intraoral height? Locating 60 on the vertical scale of Figure 3, and following horizontally across the striped band, it is found that 4 children in 5 erupt 60 per cent of intraoral height in periods varying from less than 3 months to almost 7 months. One may conclude that unless tooth movement were unusually slow, child X would reach the 60 per cent stage within 7 months after the assumed observation.

2. A permanent lower second premolar is seen to have pierced the alveolar mucosa in child Z. What estimate can be made regarding the time it will take this tooth to attain 80 per cent of its intraoral height? The same procedure, locating 80 on the ordinate scale of Figure 3 and determining the limits of the striped band at this level, shows that 4 children in 5 erupt 80 per cent of full intraoral height in periods varying between 5 months and 16 months. It follows, unless tooth migration were exceptionally rapid in child Z, the 80 per cent stage would not be attained until at least 5 months from the observed gingival emergence.

Summary

This study pertains to the eruptive movement of six permanent teeth during the first four years after they pierce the alveolar mucosa. Principal aims include determining for each tooth the mean trend of increase in intraoral height, describing the variability of intraoral tooth height at selected times, calculating statistics on the intervals occupied in erupting different percentages of maximum intraoral height, and presenting a tooth migration reference chart.

Data were obtained from hydrocal casts of the maxillary and mandibular arches amassed on seventy-five children participating in a longitudinal research program. The sample constituted a group of American-born white children predominantly of northwest European ancestry and above average in socioeconomic status. For every subject, dental casts were available at successive semiannual (below age twelve years) or annual ages beginning prior to gingival emergence and extending four years thereafter.

Findings include the following:

1. Intraoral eruption of the permanent central incisor, canine, and second premolar teeth proceeds at a progressively slowing rate during the early years after gingival emergence. This holds for the individual as well as for the group.

2. On the average, the absolute amount of intraoral tooth eruption is (a) greater for the maxillary central incisor than for its antagonist, and (b) less for the maxillary second premolar than for its antagonist. Although the maxillary canine tooth erupts faster than its antagonist during the first six months following gingival emergence, intraoral height four years later is similar in both dental arches.

3. Permanent central incisor and canine teeth typically take between 3.0 months and 3.5 months to erupt the first one-half of their respective intraoral heights. Permanent second premolar teeth reach the same stage in approximately 2.5 months. The average time occupied in erupting 90 per cent of intraoral tooth height approximates 13 months for the second premolars and maxillary canine, and 19 months for the central incisors and mandibular canine.

4. The 50 per cent level of intraoral

migration is reached by all second premolar teeth in less than 5.0 months, and by all central incisor and canine teeth in less than 7.0 months. Always 90 per cent or more of maximum intraoral tooth height is present by 3.5 years after gingival emergence.

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