Serial Data On Primary Incisor Root Resorption And Gingival Emergence Of Permanent Successors

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This investigation pertains to the course of root resorption of four primary incisor teeth. Maxillary and mandibular central and lateral incisors are studied from initial root resorption of each primary tooth to gingival emergence of their successors. Data are drawn from intraoral roentgenograms obtained through longitudinal study of 145 North American white children.

OBJECTIVES

The purpose of this investigation is to present analyses of data for resorption of the roots of two maxillary and two mandibular primary incisor teeth.

Specific aims are:

1. To determine the median age and variability in age for three stages of root resorption designated (a) initial, (b) one-half and (c) three-fourths.

2. To analyze individual differences in the period of time from each of these root resorption stages to gingival emergence of permanent successors.

3. To classify and tabulate types of root resorption at initial and advanced stages.

4. To examine relationships between resorption age, gingival emergence age, and length of resorption time for the four incisor teeth.

SUBJECTS

The subjects were 70 boys and 75 girls living in or near Iowa City, Iowa, all voluntary participants in a long-term research program conducted at the University of Iowa.* Enrollment was based on willingness to participate and likelihood of continued residence in the community and was not related to orthodontic or other dental conditions.

The population sampled may be further characterized as healthy white children predominantly of northwest European ancestry and above average in socioeconomic status.

MATERIALS AND METHODS

Data were derived from intraoral roentgenograms, dental casts and supplemental records obtained at semi-annual intervals from age four years through twelve years. The materials were obtained within a week of each subject's birth anniversary and mid-anniversary dates.

Serial data were complete on 526 of the 580 teeth (four incisor teeth on 145 subjects). Teeth were omitted as follows: a relevant film missing or unclear (6 per cent); no successor emergence age available (2 per cent); a tooth injured or removed (1 per cent).

Estimates of age at three stages of primary root resorption, initial, one-half, and three fourths, were made for the left primary central and lateral in-

*The Facial Growth Study. Collection of material was under the direction of Howard V. Meredith (1946-1960), L. Bodine Higley (1946-1954), and Ernest H. Hixon (1954-1960).

cisor in each dental arch by two investigators working independently. For each tooth, the pertinent film series was examined in sequence on an illuminated viewing table with the aid of a magnifying lens. In those instances in which the left incisor was extracted or the film quality unacceptable, data were obtained for its antimere. When initial estimates agreed within 0.2 years, the average of the two was used. In instances of greater discrepancy, two additional estimates were taken and either the mean of the four utilized, or when one value represented an obvious error, the mean of the other three.

Approximately 86 per cent of the initial paired independent estimates agreed within the established limits. By category these included 71 per cent of the age values for initial resorption stage and 93 per cent of the age values for one-half and three-fourths resorption stages.

"Initial" stage of root resorption is defined as the earliest radiographic evidence of resorption regardless of its location. Intraoral films at age four years showed no resorption for an incisor tooth in over 95 per cent of subjects. In the remainder, resorption initiation was observed on the first film in the series. Estimates of initial resorption age for these subjects were included since their omission would yield a biased estimate of average age at initial resorption.

Resorption stage "one-half" refers to the stage when only one-half of the root mass remains; resorption stage "three-fourths" means that three-fourths of the total root mass has been resorbed and one-fourth of the root remains.

The type of root resorption was classified independently by the two investigators as lateral, apical, or apical-lateral at the initial stage, horizontal or diagonal at advanced stages. Instances of disagreement were resolved by repeating independent judgments and using the resulting homogenous designations, or, in several instances, by examining the films jointly until agreement was reached.

Age of gingival emergence for each of the permanent teeth studied had been determined previous to this investigation. The procedure used to assemble these data for estimated "age at which the alveolar mucosa is pierced and exposure of the crown of a tooth approximates one millimeter in diameter" has been described elsewhere.[3,5]

Age at Different Stages of Primary Incisor Root Resorption

For each sex, Table I lists the 10th, 50th and 90th percentiles for age at three stages of resorption of two primary incisor teeth in each dental arch and age at gingival emergence of their respective permanent successors. It may be noted that:

1. Age values at each of the listed percentiles are generally similar for the two sexes.*

2. The median age of initial root resorption approximates 5.5 years for the two central incisor teeth and 6 years for the two lateral incisor teeth.

3. Commonly, the roots of the maxillary and mandibular central incisor teeth are one-half resorbed near age 6 years. For the maxillary and mandibular lateral incisors, one-half resorption occurs about 8 months later.

4. The median ages for gingival emergence of permanent incisor teeth were found to be from 0.1 years to 0.7 years subsequent to the median ages for three-fourths root resorption of their predecessors.

*In all instances, values obtained from application of t-tests to the 16 paired distributions were too low to reject (at the 1 per cent level of confidence) the hypothesis that distributions for the two sexes were drawn from the same population.

TABLE I

Age (in years) for Three Stages of Primary Incisor Root Resorption and for Gingival Emergence of Permanent Successors

Tooth Stage	Percentiles					
	10	50	90	10	50	90
	Males			Females		
Maxillary Central Incisor (63 males, 58 females)						
Initial	3.9	5.8	6.7	3.8	5.4	6.6
One-half	5.5	6.3	7.2	5.3	6.2	7.1
Three-fourths	5.8	6.5	7.4	5.6	6.4	7.4
Successor Emergence	6.3	7.0	7.9	6.1	6.8	7.8
Maxillary Lateral Incisor (64 males, 66 females)						
Initial	5.4	6.2	7.4	4.8	6.0	7.2
One-half	6.3	7.1	8.0	5.8	6.7	8.1
Three-fourths	6.4	7.3	8.3	6.0	7.1	8.2
Successor Emergence	7.1	8.0	8.9	6.9	7.8	8.8
Mandibular Central Incisor (65 males, 72 females)						
Initial	4.5	5.5	6.5	4.5	5.5	6.4
One-half	4.8	5.8	6.7	4.9	5.8	6.7
Three-fourths	5.0	6.0	6.8	5.1	5.9	6.8
Successor Emergence	5.2	6.1	7.0	5.3	6.1	6.8
Mandibular Lateral Incisor (66 males, 72 females)						
Initial	5.1	6.2	7.4	5.1	6.0	7.1
One-half	5.7	6.7	7.7	5.6	6.7	7.7
Three-fourths	5.9	6.9	7.9	5.8	6.8	7.8
Successor Emergence	6.2	7.2	8.3	6.2	7.2	8.1

5. Fifty per cent of the primary teeth were replaced by successors as follows: at age 6 years (mandibular central incisor), at age 7 years (maxillary central and mandibular lateral incisor) and at 8 years of age (maxillary lateral incisor).

6. Examination of an intraoral film of a child just over 6 years of age would typically show the root of the mandibular central incisor three-fourths resorbed, the root of the maxillary central incisor nearly one-half resorbed, and the roots of the two lateral incisors with resorption just beginning.

7. The variability in age at initial resorption is greatest for the maxillary central incisor. The central 80 per cent vary in this age by nearly three years while the age variability for the other incisor teeth approximates two years.

8. At stages of one-half and three-fourths root resorption, there is a maximum difference in age among the central 80 per cent of about one and one-half to two years depending on the tooth examined.

Individual Variation in Time Interval for Root Resorption

From the serial data individual values for time between age at different

TABLE II

Time (in months) from Three Stages of Primary Incisor Root Resorption to Gingival Emergence of Permanent Successors

Interval	Incisor Tooth	Percentiles*				
		10	25	50	75	90
Initial Root Resorption to Successor Emergence	*Mandibular*					
	Central	3	5	7	9	12
	Lateral	7	9	13	16	21
	Maxillary					
	Central	10	12	15	27	35
	Lateral	11	15	20	26	35
One-half Root Resorption to Successor Emergence	*Mandibular*					
	Central	1	2	3	5	7
	Lateral	3	4	6	7	11
	Maxillary					
	Central	5	6	8	11	16
	Lateral	5	7	11	15	20
Three-fourths Root Resorption to Successor Emergence	*Mandibular*					
	Central	0	1	2	3	4
	Lateral	1	2	3	5	9
	Maxillary					
	Central	2	4	5	8	11
	Lateral	3	5	7	12	15

*For each tooth, percentiles are based on approximately 130 subjects, 65 of each sex.

stages of root resorption and age at gingival emergence of permanent successor were determined. In Table II five percentile points whose values are based on the distribution of three intervals for each of the four incisor teeth are shown for the sexes combined.*

It is noted:

1. The median time interval from initial resorption of the root of a primary tooth to the gingival emergence of the succeeding permanent tooth is shortest for the mandibular central incisor (7 months), intermediate for mandibular lateral and maxillary central incisors and longest for the maxillary lateral incisor (20 months).

2. The full course of root resorption and shedding for the mandibular central incisor tooth occurs in less than one year for 90 per cent of this group of children. By contrast, for the two maxillary incisors, initial resorption to successor emergence occurs in this length of time for less than 25 per cent of the children and extends over a three year period for 10 per cent.

3. From the time at which one-half of the root was resorbed, 50 per cent of the children showed emergence of the permanent successor within 3 months for the mandibular central incisor, 6

*The Mann-Whitney U test was used to test the hypothesis that the distribution of intervals was the same for the two sexes. This null hypothesis could not be rejected for any of the twelve distributions at the 1 per cent level of confidence.

months for the mandibular lateral incisor, 8 months for the maxillary central and 11 months for the maxillary lateral incisor.

4. Typically, the interval from three-fourths resorption stage to permanent successor emergence varies from 2 months for the mandibular central incisor to 7 months for the maxillary lateral incisor.

5. The twelve distributions presented are all positively skewed. For example, the spread for the maxillary central incisor is 5 months between the 10th and 50th percentile and 20 months from the 50th to the 90th percentile.

Variation in Pattern of Resorption

Throughout the course of root resorption, several different resorption types were classified as illustrated in Figure 1. At the initial stage three types are differentiated according to the area first showing resorption: *apical* (resorption noted at the apex of the root only), *lateral* (resorption only on a lateral aspect of the root), and *apical-lateral* (initial resorption both at the apex and laterally).

For advanced stages, after at least one-fourth of the root was resorbed, two types were distinguished. *Horizontal* designates resorption that appears relatively symmetric, that is, roughly paralleling a line perpendicular to the long axis of the primary tooth. The resorption classed as *diagonal* is asymmetric and involves resorption of either or both sides of the root.

Assembled in Table III are data on types at early and later stages. The upper portion of the table shows the frequency of type of initial resorption for 302 incisor teeth based upon films on which resorption was visible but involved less than one-fourth of the root mass. This subgroup includes approximately two-thirds of the maxillary central, maxillary lateral and mandibular lateral incisor teeth of the total sample. For the mandibular central incisor teeth this subgroup includes only about one-third of the total sample. Fewer observations at this early stage of resorption were available for this tooth since nearly two-thirds of the group proceeded from no evident resorption to an advanced stage (20 per cent) or to completion of root resorption (42 per cent) within the six month interval between films. Findings from this section of the table are:

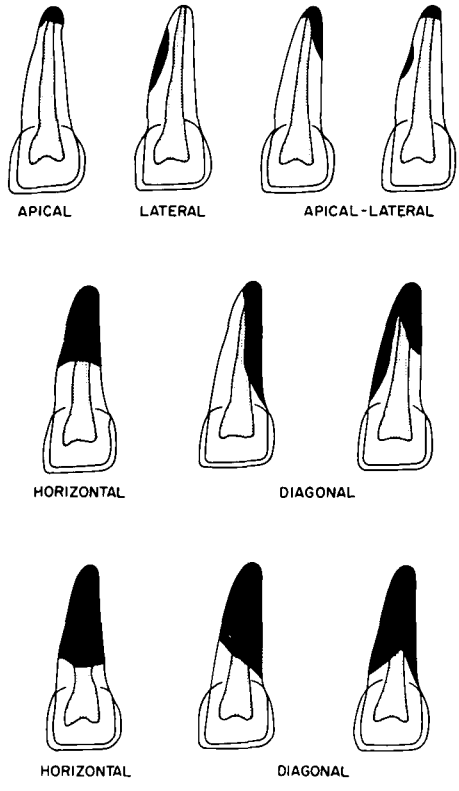

Fig. 1. Varieties of primary incisor root resorption at three stages: initial (top row), one-half (middle row) and three-fourths (bottom row).

1. For the mandibular central incisor teeth, initial resorption was rated as *apical* in 72 per cent of the 43 teeth. The remainder showed lateral or apical-lateral initial resorption with about equal frequency.

TABLE III

Classification of Root Resorption

A. *Initial Stage*

Tooth	Number Observed	Type of Resorption					
		Apical		*Lateral*		*Apical-Lateral*	
		N	Per cent	N	Per cent	N	Per cent
Mandibular Arch							
Central Incisor	43	31	72.1	5	11.6	7	16.3
Lateral Incisor	87	17	19.5	55	63.2	15	17.2
Maxillary Arch							
Central Incisor	76	14	18.4	48	63.2	14	18.4
Lateral Incisor	96	13	13.5	60	62.5	23	24.0

B. *One-half Stage*

Tooth		Type of Resorption			
		Horizontal		*Diagonal*	
		N	Per cent	N	Per cent
Mandibular Arch					
Central Incisor	55	43	78.2	12	21.8
Lateral Incisor	80	44	55.0	36	45.0
Maxillary Arch					
Central Incisor	86	29	53.7	57	66.3
Lateral Incisor	93	10	10.8	83	89.2

C. *Course from Initial to One-half Stage*

Initial Resorption		Later Resorption			
		Horizontal		*Diagonal*	
		N	Per cent	N	Per cent
Apical	48	38	79.2	10	20.8
Lateral	91	17	18.7	74	81.3
Apical-Lateral	39	6	15.4	33	84.6

2. The most frequently observed type of initial resorption for maxillary central and maxillary and mandibular lateral incisor teeth was *lateral* resorption (63 per cent for each tooth). The remaining 37 per cent were about evenly divided between the apical and apical-lateral types.

For the 302 teeth taken together, the lateral type of initial resorption was most frequently observed (about 55 per cent of teeth) while the remaining 45 per cent were rated as often apical as they were apical-lateral for initial resorption. The time interval from initial resorption to successor emergence for these teeth was not found to be related to site of initial resorption.

For the 168 teeth with initial lateral resorption, additional estimates were made for age at the initiation of *apical* resorption. This type of resorption was found to be as much as two years later than the first resorption noted on the root. The median difference was 6 months while the 10th and 90th percentile values were 2 months and 13 months, respectively.

Location of the resorption site for teeth with initial lateral resorption

differs for central and lateral incisors. For central incisors, initial resorption was most commonly observed on either the distal root surface or on both mesial and distal surfaces with about equal (40 per cent) frequency. For lateral incisor teeth, the most frequent location was on the mesial root aspect (69 per cent). Of these, over 90 per cent appeared to result from "ectopic eruption" of an adjacent permanent tooth as reported in earlier studies.[1,4]

Section B of Table III presents a summary of judgments on type of resorption viewed on 314 films of teeth near stage one-half root resorption. Again, relatively fewer observations were available for the mandibular central incisor because of the rapid resorption of its root. Referring to the table, it will be seen:

1. For the two maxillary incisor teeth, root resorption for nearly four out of five was rated as diagonal: 66 per cent for the central and 89 per cent for the lateral tooth.

2. In the mandibular arch, horizontal resorption was more often noted than diagonal: 78 per cent for the central and 55 per cent for the lateral incisor teeth.

The final section of Table III presents the subsequent course of resorption for the three initial types. For 178 of the 302 teeth in section A, there was a successive film near stage one-half showing resorption categorized as horizontal or diagonal. From section C, we note that 80 per cent of the time, an *apical* initial resorption was followed by the *horizontal* type (38 of 48 teeth) while *lateral* and *apical-lateral* initial resorption progressed to a *diagonal* type (107 of 130 teeth).

Associations for the Incisor Teeth Between Resorption Age, Gingival Emergence Age, and Duration of Resorption Time

The upper portion of Table IV presents correlation coefficients between age at each of three resorption stages and interval from this designated stage to successor emergence. In the lower section of this table correlation statistics are assembled for age at initial resorption among adjacent or opposing primary incisor teeth. This table shows:

1. The obtained negative coefficients for age at designated resorption stage and interval to successor emergence vary in size from .08 to .76. For pairings yielding r's above .23, the hypothesis that the obtained correlation could have occurred by chance (assuming no association for the population) may be rejected at the 1 per cent level of confidence.

2. Among the four incisor teeth, association between age at initial resorption stage and subsequent interval to successor emergence was moderately high for the maxillary central incisor ($r = -.76$), indicating that early initial resorption for this tooth is associated with the longer intervals to successor emergence and later initial resorption with shorter intervals.

3. The variables of age at one-half root resorption and intervals to successor emergence show a low negative relationship, while there is virtually no association between age at three-fourths resorption and interval to emergence of permanent successor.

4. Correlation coefficients for age at initial resorption for combinations of incisor teeth which are either opposing or adjacent lie between $r = .63$ and $r = .83$. The highest relationship for age at initial root resorption is found for the mandibular central with mandibular lateral incisor. In every instance the hypothesis that the correlation statistic could have occurred by chance in sampling from a population in which there is no association may be rejected at the 1 per cent confidence level.

TABLE IV

Correlation Coefficients*

Relationship Between Age at Given Resorption Stage and Interval from This Resorption Stage to Gingival Emergence of Successor

Resorption Stage	TOOTH			
	Maxillary Central	Maxillary Lateral	Mandibular Central	Mandibular Lateral
Initial	—.76	—.59	—.40	—.40
One-half	—.34	—.43	—.16	—.20
Three-fourths	—.13	—.35	— 08	—.19

Relationships for Age at Initial Resorption of Primary Incisor Teeth

Variables Correlated	*r*
Maxillary Central and Maxillary Lateral	.64
Mandibular Central and Mandibular Lateral	.83
Maxillary Central and Mandibular Central	.63
Maxillary Lateral and Mandibular Lateral	.71

*Boys and girls combined: for each sex, N varies from 45 to 70.

5. Collectively, the statistics presented in the lower portion of Table IV support the generalization that early beginning resorption of one primary incisor root is likely to be associated with younger than average age for initial root resorption of the adjacent and opposing incisor tooth and late initiation for one, with older ages for the other.

Prediction equations were sought which would yield improvement in forecasting of at least 35 per cent over mean-age estimates. Two of the obtained *r*'s satisfy this criterion:

1. A negative *r* of .76 was obtained from the paired distributions for age at initial root resorption of the maxillary primary central incisor and the length of time to the gingival emergence of the succeeding permanent central incisor. The regression equation from this sample is:

Interval = —.68 Age in years +5.34

Application of this equation to predict length of time to successor emergence for a child whose primary maxillary incisor tooth begins root resorption at age 4 years yields a best estimate of time to successor emergence of 2.62 years (31 months). Comparable values at ages 5, 6 and 7 years are 1.94, 1.26 and .058 years or 23, 15 and 7 months. The standard error of estimate is reduced 35 per cent (from approximately 11 to 7 months) with the use of this information.

2. Ages at initial root resorption of the mandibular incisors show a moderately high relationship ($r = .83$). A prediction equation based on this association is:

Age (mandibular lateral) =
Age (mandibular central) +.67

Or simply, the best estimate of age of initial root resorption of a mandibular lateral incisor tooth is 8 months after the beginning of resorption for

the adjacent mandibular central incisor. The standard error of this estimate is .47 years, an improvement in prediction efficiency of 43 per cent.

Additional analyses were employed to determine the order of initiation of primary incisor root resorption. This sequence was studied in 53 boys and 50 girls who contributed data for all four primary incisor teeth to the study. Fourteen variations in sequence were noted when the age at initial resorption for each primary incisor tooth was ordered from earliest to latest for each subject.

The most common sequences for the maxillary central (U1), mandibular central (L1), maxillary lateral (U2), and mandibular lateral (L2) incisors were:

U1, L1, L2, U2 (27 per cent)
L1, U1, L2, U2 (21 per cent)
U1, L1, U2, L2 (14 per cent)
L1, U1, U2, L2 (7 per cent)

It was further found that:

1. In 93 per cent of the subjects the first tooth to begin resorption was a central incisor. This figure combines 52 per cent for the maxillary incisor and 41 per cent for the mandibular incisor.

2. Fifteen per cent of the time, root resorption began at an earlier age on a lateral incisor than on the central incisor in the same arch.

3. Initial resorption of the mandibular lateral incisor *precedes* that of the maxillary lateral incisor about 60 per cent of the time while beginning resorption of the mandibular central incisor *follows* that of its complementary tooth about 60 per cent of the time.

4. Root resorption of the second tooth in the sequence began for two-thirds of the group within 6 months after initial resorption of the first tooth, 14 months for 90 per cent, and within 25 months for the remainder.

5. The time interval from initial root resorption of the first tooth to initial resorption of the fourth tooth was about 16 months for one-half of the children. The 10th and 90th percentile values were 8 months and 28 months, respectively.

Comparative Findings

A single previous investigation was located which considered chronology of primary incisor root resorption.[2] This report is based on roentgenograms for 48 boys and 51 girls accumulated largely in the 1930's and 1940's on children enrolled for study at the Center for Research in Child Health and Development, Harvard School of Public Health. The study is similar to the present study in respect to type of material analyzed: both are based on serial data derived from intraoral films obtained semi-annually over the same age period. Certain differences between the two studies with respect to methods and findings may be noted.

In Fanning's report, stages of root resorption of deciduous incisors were assessed by reference to a series of seven drawings. Initial resorption stage was defined as the stage where the root "shows blunting or rounding at apex." No note was made of the lateral and apical-lateral types described in the present study. The various later stages depicted do not conform with those observed in the present investigation as shown in Figure 1. The diagrams presented by Fanning show the resorption process following a single symmetric course from initial apical to later horizontal stages. The majority of the 526 teeth in the present report were not judged as following this pattern. In some instances, for example, over one-fourth to nearly one-half of the root mass was resorbed prior to evidence of apical involvement.

Certain comparisons of the findings

in Table I may be made with those from the study of Fanning.

Percentiles for age at *initial* root resorption of primary incisor teeth were reported by Fanning only on the two left lateral teeth for females. The 10th, 50th and 90th percentiles are all approximately one year earlier (median age, 5 years) than in the present study (median age, 6 years). Moreover, 43 per cent of the primary lateral incisor teeth of girls in the present report were judged to have initial resorption of the lateral type which has been shown to be earlier than apical initiation for the same subjects. It follows that the differences between ages on these two samples would have been greater if initial lateral resorption had been ignored in the present study and apical blunting considered as the initiation of root resorption.

For all four incisor teeth, the median ages at one-half root resorption for both sexes are reported in both studies. In all comparisons the ages are later in the present study. The differences are appreciable for the maxillary central incisors (one year) and slight for the maxillary lateral incisors (two months).

For age at three-fourths root resorption, the findings in the present study, on the average, were earlier by three months.

The median ages for gingival emergence of successional teeth found in the present study were earlier than the median ages for corresponding incisor exfoliation reported by Fanning.

To compare the same data from another viewpoint, time intervals between age at different stages may be examined by subtracting (a) median age at initial root resorption from median age at one-half resorption and (b) median age at one-half from median age at three-fourths resorption in both studies. Data for median interval from initial to one-half root resorption is limited to the two lateral incisors for females in Fanning's investigation. In the present study the interval approximates 8 months for both lateral incisors while much larger values (approximately 18 months) are derived from Fanning's data.

The age difference in medians from one-half to three-fourths root resorption is 2 to 3 months in the present investigation for all four incisor teeth for both sexes. From Fanning, these age differences vary from 8 months (mandibular lateral incisor, females) to 15 months (mandibular lateral incisor, males), and average about 12 months.

Summarizing, the earlier study shows resorption to be initiated at the root apex and to progress in a symmetric manner to later horizontal stages. In the present investigation resorption was judged to begin on varied aspects of the root surface and proceed in either an asymmetric (diagonal) or symmetric (horizontal) way. The present study found the course of incisor root resorption to start later and to be of much shorter duration.

Summary

This investigation was designed to study the course of root resorption for two maxillary and two mandibular primary incisor teeth. The data were derived from intraoral roentgenograms and dental casts obtained on 145 Iowa children of northwest European ancestry and above average socioeconomic level, enrolled in a longitudinal research program. Casts and films were available at semiannual ages from early childhood to age twelve years. Estimates of age at three stages of primary root resorption, (a) initial, (b) one-half and (c) three-fourths, were made for the left central and lateral incisor in each dental arch by two investigators working independently.

Specific aims included: (1) determining age distributions for the three stages of root resorption, (2) analyzing individual differences in time from each of these stages to gingival emergence of permanent successors, (3) classifying and tabulating various root resorption types, and (4) examining associations between resorption age, gingival emergence age and length of resorption time for the four incisor teeth. It is found:

1. For both sexes, median ages at initial resorption for the central incisor teeth in each arch are around 5.5 years and for the two lateral incisors, 6.0 years.

2. Individual differences in age at initial resorption are greatest for the maxillary central incisor: the central 80 per cent of the children varied in this age from before age 4 years to beyond age 6.5 years.

3. The course of root resorption for the mandibular central incisor is completed in less than a year for nine out of ten children. The median time interval from initial resorption to successor emergence is shortest for this tooth (7 months) and of longest duration for the maxillary lateral incisor (20 months).

4. From one-half root resorption to successor emergence, median time intervals are 3 and 6 months for the central and lateral incisor in the mandibular arch and 8 and 11 months in the maxillary arch. For the interval from three-fourths root resorption to successor emergence, the values are approximately 3 months in the lower arch and 6 months in the upper arch.

5. Variation in location of initial root resorption and pattern of progression of resorption is noted. Overall, initial resorption was most commonly rated as lateral. The course of resorption from initial to one-half stage is seen to proceed from apical to horizontal or from lateral to diagonal 80 per cent of the time.

6. Coefficients of correlation for age at designated resorption stage with interval to successor emergence vary in magnitude from $r = -.08$ to $-.76$. Associations are highest between age at initial resorption stage and time interval from this stage to successor emergence.

7. The variables of age at initial resorption for incisor teeth which are either opposing or adjacent show a moderate positive relationship (r's from .63 to .83).

8. While either the upper or lower central incisor tooth is the first to show evidence of root resorption in 93 per cent of the subjects, different sequences in time of initial root resorption for the four incisors numbered fourteen.

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