Earlier dental maturation: Fact or fiction?

George L. Nadler, DDS

It appears that we are initiating orthodontic treatment on adolescent patients in our office earlier than we were 20 years ago. Is this difference a result of orthodontic mechanotherapy? Is it due to lack of available patients? Or is it due to the earlier maturation of adolescents? The objective of this study was to determine if a difference exists between the dental age of maturation of patients treated in the 1970s versus those treated in the 1990s, measured by radiographic tooth calcification patterns.

Puberty is characterized by the onset of secondary sexual changes and a dramatic increase in growth velocity, or a growth spurt. The first physical signs of sexual maturation include breast budding in females and testicular enlargement with scrotal changes in males. In general, girls start puberty 1.5 to 2 years earlier than boys.[1,2] In the middle of the last century, the average recorded age for menarche was 17.5 years.[3] Since then, the average age in the United States, as in industrialized European countries, has decreased by approximately 2 to 3 months per decade. An important aspect in the timing of menarche for the adolescent female is attaining a critical body weight and body fat percentage.[4] Although puberty is under genetic/hormonal control, socioeconomic conditions, state of health, and nutritional status are thought to be responsible for this decrease. Earlier onset of puberty results in earlier developmental stages of height, weight, bone, and tooth maturation.

Lewis and Garn's[5] longitudinal study of 255 healthy Caucasian middle class children compared tooth formation with variables of height, weight, subcutaneous fat thickness, bone age, and menarche in girls. They reported that girls have an earlier tooth eruption pattern than boys, and as adolescence approaches, a relationship between maturational status and tooth formation

Abstract

The objective of this investigation was to determine if there is a difference in dental age of maturation between adolescents treated in the 1970s and those treated in the 1990s. Records of 150 Caucasian patients, 8.5 to 14.5 years old and treated in a private orthodontic office between 1972 and 1974, were randomly selected; records of another 150 patients of the same race and age range but treated between 1992 and 1994 were also collected. The percentage of calcification of the mandibular canines was rated according to methods used by Demirjian, who divided tooth development into eight segments, A to H. Using stage G to compare the 1970 and 1990 patient samples, we demonstrated dental age reductions of 1.21 years for males and 1.52 years for females, and a combined reduction of 1.40 years.

Key Words

Age of dental maturation • Calcification of mandibular canines

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Table 1
Sample demographics

Years	1970s		1990s		
	N	Mean age	N	Mean age	Mean diff
Total sample	150	12.16	150	11.13	1.03
Males	69	12.40	65	11.51	0.89
Females	81	11.93	85	10.85	1.08

Table 2
Distribution of stages of calcification, tooth 43 (FDI tooth numbering system)

	Males		Females	
Stage	1970s	1990s	1970s	1990s
E	5	3	4	2
F	6	8	8	8
G	34	27	28	29
H	24	27	41	46
Total	69	65	81	85

Figure 1
Schematic appearance of tooth development, stages E-H

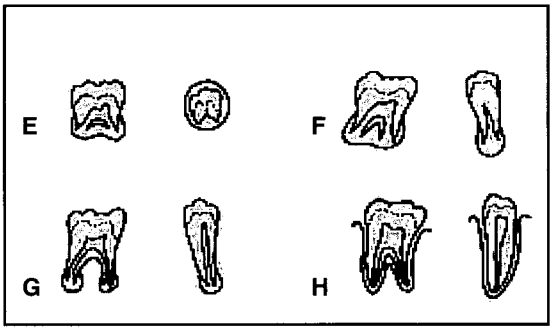

Figure 1

becomes evident. In a similar study, Anderson[6] correlated dental and skeletal mineralization, height, and weight for boys and girls between 4 and 14 years. He found that a significant relationship exists between the stages of dental, skeletal, and growth development attained during preadolescent and adolescent ages. He noted that using dental maturation scores of individual teeth was preferable to comparing mean scores for groups of teeth.

Chertkow and Fatti[7] and Sierra[8] noted that a relationship exists between tooth development and skeletal development. The maturation index used in their comparisons was the calcification of the mandibular canine and the centers of ossification in the hand.

Gingival emergence of the teeth represents only one stage in the process of dental eruption to reach the occlusal level. It is influenced by various local factors, such as ankylosis, impacted and/or crowded permanent teeth, and early extraction and/or overretained primary teeth. Visual emergence usually occurs when root formation is three-fourths complete. Demirjian et al.[9] felt that analyzing the calcification of teeth, not the eruption, was more accurate in determining dental age.

According to Chertkow,[10] anticipating the timing of future growth spurts is essential to ensuring a successful outcome of orthodontic therapy. He stated that the adolescent growth spurt is highly correlated with the calcification pattern of teeth, especially the lower canines. In his investigation of 197 black and white South African children, he concluded that use of the canine as a maturational indicator was especially valid in white boys and girls. Among the white children he studied, calcification of the mandibular canine just prior to apical closure coincided with other indicators of a pubertal growth spurt.

The present study complements the investigations of Anderson,[6] Demirjian,[9] Chertkow,[7,10] and Sierra.[8] The focus of this study was to compare the dental ages at which specific tooth calcification occurs in two groups of patients whose treatment was separated by approximately 20 years, using the calcification of teeth as maturational indicators. The indicator for this determination was the lower right canine (tooth 43, FDI system).

Materials and methods

Data obtained for this retrospective study was randomly selected from the records of 150 patients treated between 1972 and 1974, and from a similar 150-patient sample treated between 1992 and 1994.

All initial radiographic assessments were made by the principal investigator. Fifty-seven percent of the records were reevaluated independently by two orthodontists. The interrater reliability, using the weighted Kappa, met or exceeded .800 (Kappa range .800 to .940).

Patient selection was limited by the following:

1. Age range 8.5 years to 14.5 years of age
2. Caucasian children only. (We limited this study to Caucasian children to avoid various factors associated with differences in maturation rates as noted in numerous other studies[7,8,10,11])
3. Middle socioeconomic group
4. Negative past and current medical history

The investigation of panoramic radiographs was limited to the evaluation of growth and development of the mandibular right canine (tooth 43). The percentage of tooth calcification was rated according to the method used by Demirjian et al.,[7] dividing the stages of tooth calcification into eight segments, A to H. In this study we used only stages E to H. Tooth calcification was

Table 3
1970s/1990s male/ female mean and median ages of F/G stage

	Males 1970s		1990s		Females 1970s		1990s	
Stage	F	G	F	G	F	G	F	G
N	6	34	8	27	8	28	8	29
Mean	10.78	12.23	10.52	11.02	10.18	11.72	9.86	10.20
Median	10.96	12.17	10.75	10.75	10.21	11.88	9.75	10.25
SD	0.914	0.771	0.854	1.295	1.46	0.858	0.858	0.702

correlated with the patient's chronological age at the time of evaluation. Pertinent tooth calcification stages are shown in Figure 1.

Maturational stages are defined when the following characteristics are discernible:

Stage E: Root length remains shorter than crown height.

Stage F: The walls of the pulp chamber form an isosceles triangle, and root length is equal to or greater than crown height.

Stage G: The walls of the root canal are now parallel, but the apical end is partially opened.

Stage H: Root apex is completely closed. The periodontal ligament surrounding the root and apex is uniform in width throughout.

The following information was recorded for each patient: chronological age in years and months, sex, and stage of development of the lower right canine (tooth 43).

Results

Demographics of the patient population for this study are given in Table 1.

Female patients outnumbered males in both the 1970s sample and the 1990s, comprising 54% and 57% of the samples, respectively. These numbers agree with the demographics generally seen in orthodontic offices. The mean chronological age in the total sample, comparing 1970s and 1990s samples, indicated a reduction of 1.03 years, with males younger by 0.89 years and females younger by 1.08 years.

Distribution by sex for stages E through H is summarized in Table 2.

The number of teeth present at stage E was not large enough to be significant, so those subjects were eliminated from the study. The H calcification or complete closure of the apex was also eliminated, as we are unable to determine with any degree of certainty when this occurred. Only the F and G stages were used for comparison data. Our initial sample size for each group—the 1970s and 1990s—was 150 patients. Once the E and H stage patients were eliminated, only 76 subjects remained in the 1970s sample and 72 in the 1990s group, (or a total of 148), a reduction of almost 50% of the sample size.

Table 4
Mean age differences between 1970s and 1990s data

Stage of calcification	G	F
1990s-1970s male	1.21	0.26
1990s-1970s female	1.52	0.32
1990s-1970s total	1.40	0.30

The data for stages F and G calcification, the mean ages, the median ages, and the standard deviations are displayed in Table 3.

The F stage sample was small in all groups, indicative of advanced developmental levels at the initial treatment visit. Differences of central tendency measure, mean, and median were uniformly small for both sets of years, indicating homogeneity of the population sample.

The objective in this investigation was to determine if there was a mean chronological age difference between the 1970s group of adolescents and the 1990s group, using calcification of 43. The difference in years between the 1990s data and the 1970s data is shown in Table 4.

This table compares the mean differences in both stages F and G of the male, female, and total patient populations. In the stage G patient sample, the mean chronological age reductions were 1.21 years for males, 1.52 years for females, and 1.40 years for the combined sample. In the F patient sample, the mean chronological age reductions were 0.26 years for males, 0.32 years for females, and 0.30 for the total patient population.

Discussion

During the 1970s, the mean chronological age for the onset of menarche was reported to be 12.8 years.[11,12] A recent cross-sectional study of pediatric practices from across the United States reported that girls are developing pubertal characteristics at a younger age than previously

suggested in standard pediatric textbooks. On average, African American girls now begin puberty between 8 and 9 years of age, and Caucasian girls by age 10.[13] The results of this study are in agreement with this trend. In stage G, the mean age of dental maturation comparing the 1970s and the 1990s data indicated that calcification of the mandibular canine was occurring earlier. The changes included reductions of 1.21 years for males, 1.52 years for females, and 1.40 years for the total sample. This trend may lead to earlier treatment of these patients.

According to Fishman,[14] each individual has his or her own pattern of growth velocity that is specific and unique and does not conform to the pattern exhibited by the general population. However, there are identifiable maturational variants, such as the calcification of the mandibular canine, that can be used to evaluate and categorize the dental age of maturation at various stages of tooth calcification. Coutinho et al.[15] reported that adolescents at stage G showed the presence of the adductor (81%), capping of the diaphysis of the third middle phalanx (77%), and capping of the fifth proximal phalanx (87%). Their results corroborate studies[7-10] mentioned previously, which found a relationship between the mandibular canine stage G and other indicators of pubertal growth spurt.

The above information was used to develop and define the limitations of this study, which compared radiographic evidence of earlier dental maturation between patients treated in the 1970s and those treated in the 1990s.

This clinical study contains many limitations:

1. Limitation of patient population. This is a preliminary descriptive analysis, based on Caucasian patients only; it should be expanded to include comparisons of blacks, Hispanics, Asians, and the general population.
2. Limitation of time difference. In essence, the time frame of the study was not a 20-year period, but 18 ± 4 years.
3. Limitation in differentiating accuracy of root closure. Perhaps one should consider breaking down stages F and G into F± and G±.

Conclusions

The data supports the concept that adolescents are maturing at an earlier dental age. It is important to consider earlier maturation with respect to the different treatment modalities we use. Further study is needed to determine variability patterns of tooth calcification and pubertal growth spurts for Hispanics, blacks, and Asians.

The author is in agreement with previous studies[7-10,15] that calcification of the mandibular canine in stage G is a useful tool to estimate the timing of the pubertal growth spurt. Using stage G to compare the 1970s patient sample with the 1990s patient sample demonstrated a dental age reduction of 1.21 years in males, 1.52 years in females, and 1.40 years in the total sample.

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Author Address

George L. Nadler
5610 East Grant Road
Tucson, AZ 85712-2296
E-mail: EGNadler@aol.com

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