Effect Of Extraction Of Deciduous Molars On The Formation And Eruption Of Their Successors

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Effects of environmental insults on the rate of tooth formation and the eruptive movement of permanent teeth have been determined in children with premature loss of deciduous teeth owing to dental caries and occasional abscess formation.

The material, consisting of lateral jaw radiographs taken at six-month intervals, is obtained from "The Longitudinal Studies of Child Health and Development" directed by Dr. Harold C. Stuart at the Department of Maternal and Child Health, School of Public Health, Harvard University.[1,2] The Forsyth Dental Infirmary collaborates in this project by analyzing various aspects of dental development of these children.[3,4,5,6,7,8]

From the total of 134 individuals, four boys and four girls were selected who had undergone early and unilateral extraction of a deciduous molar. Tooth development and eruption of the antimere could be used as a control since radiographs were available for both the left and right teeth of all children.

The development of the premolars was determined by assessing the amount of crown and root formation in each radiograph with reference to total tooth length, following the method of Fanning[5] for serial data. In addition, the distances from the tip of the highest cusps to the alveolar bone crest were obtained from the radiographs as an estimate of the onset of eruption and the distance that the developing tooth moved. A sliding caliper, equipped with a vernier scale, was used for all measurements to make readings of 0.1 mm possible.

The emergence of the premolar through the alveolar bone crest was noted whenever possible and, in some instances, the time of its clinical emergence could also be determined.

FINDINGS

Four analyses were made where extraction of the deciduous first molar in males occurred between the ages of 4.0 and 4.5 years, 5.5 and 6.0 years, and extraction of the deciduous second molar between 7.5 and 8.0 years, as well as between 9.0 and 9.5 years. Similarly in females, four records were examined with extraction of the deciduous first molar between 4.0 and 4.5 years, 6.0 and 6.5 years, 8.5 and 9.0 years, as well as of the deciduous second molar between 7.0 and 7.5 years.

The ages of the children at the time of extraction and the teeth extracted are shown in Table 1. The findings for each child are presented graphically in Figures 1 to 8 including the stages of tooth formation and the eruptive movement, expressed as distances from the tip of the cusp to the alveolar margin for the premolar and its control on the non-extraction side. Moreover, the findings for each individual are discussed in the legends of these figures.

Two conclusions apply consistently to

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TABLE I

The material studied related to specific teeth and age at extraction

Boys		Girls	
Tooth extracted	Age at extraction Years	Tooth extracted	Age at extraction Years
dm_1	4.0-4.5	dm_1	4.0-4.5
dm_1	5.5-6.0	dm_1	6.0-6.5
dm_2	7.5-8.0	dm_2	7.0-7.5
dm_2	9.0-9.5	dm_1	8.5-9.0

the eight analyses reported. Firstly, in all instances the rate of formation of the premolar did not change after the extraction of its deciduous precursor. Secondly, an immediate spurt occurred in the eruption of the premolar following extraction of the deciduous molar regardless of its stage of development and the age of the child.

Depending on the timing of extraction, further conclusions can be drawn from these data. Extraction of a deciduous molar before the premolar crown was completely formed resulted in a brief spurt in eruption that levelled off, the tooth remaining stationary until the

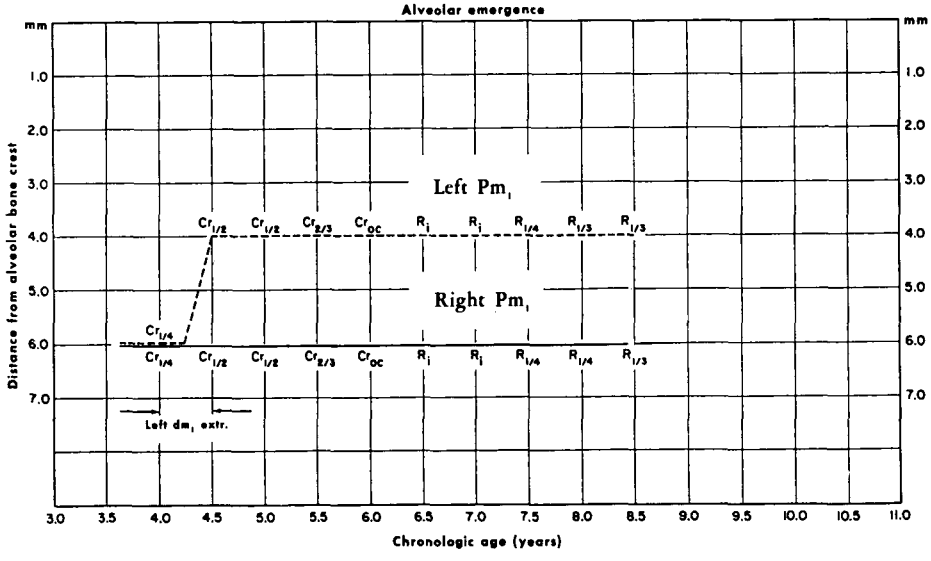

Fig. 1. At 4.0 years the developing left and right first premolars of this boy were situated 6.0 mm below the alveolar bone crest and one-fourth of their crowns had been formed. Between 4.0 and 4.5 years of age, the deciduous left first molar was extracted and in this same time interval the developing premolar crown erupted 2.0 mm towards the alveolar crest. However, the rate of crown formation did not change compared to its antimere. The position of both premolars in the mandible remained stationary from 4.5 to 8.5 years of age and the subsequent development was the same for both teeth. At 8.5 years of age there was no apparent loss of space in the dental arch, as happens frequently because of drifting of the neighbouring deciduous teeth. The permanent canines were still comparatively immature and not yet actively erupting.

root commenced to form. Thereafter, eruption of the premolar occurred again, sometimes at a slower speed than that of the control tooth on the opposite side of the mandible. In contrast, extraction of a deciduous molar at a later period when the premolar was well along in root formation and actively erupting resulted in accelerated movement and early emergence of the premolar.

Retarded eruptive movement and clinical emergence of a premolar after early extraction of the deciduous molar may be explained by the formation of scar tissue that provides a mechanical barrier to the erupting permanent tooth, while the presence of a resorbing deciduous precursor facilitates the eruption of the permanent tooth by providing a pathway for it through the alveolar bone.

The eruption of the permanent successor was accelerated in the presence of an infected deciduous tooth with abscess formation. Extensive bone destruction accompanying long-standing necrosis resulted in very early emergence of the premolar, sometimes with immature root development. Migration of the premolar was also observed occasionally.

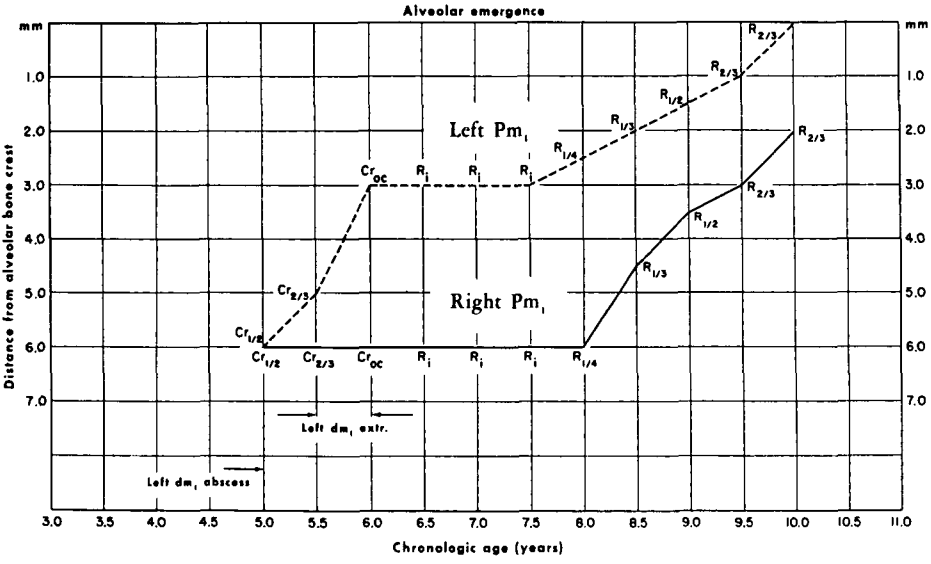

Fig. 2. At 5.0 years the developing left and right first premolars of this boy were situated 6.0 mm below the alveolar crest, and in both instances, one-half of the crown was formed. The deciduous left first molar was abscessed, the root disintegrated and the surrounding bone destroyed, resulting in 1.0 mm eruption of the left first premolar in six months. Between 5.5 and 6.0 years of age, the deciduous left molar was extracted and the premolar erupted 2.0 mm, but no change occurred in its rate of formation compared with the antimere on the non-extraction side. At 7.5 years of age when the left premolar was at stage "root initial", it again began to erupt and emerged through the alveolar crest at 10.0 years with two-thirds of its root formed. The control, the right premolar, remained stationary until 8.0 years when the root was one-quarter formed. Subsequently, its eruptive movement commenced and at 10.0 years it was 2.0 mm from the alveolar bone crest. At 10.0 years there was no apparent loss of space in the dental arch as frequently occurs after drifting of neighbouring deciduous teeth. The permanent canines were still comparatively immature and not yet actively erupting. The formation of the premolars on the extraction and nonextraction sides conformed closely at all ages.

In two instances, as shown in Figures 5 and 6, the premature loss of the deciduous mandibular first molar in girls resulted in an impaction of the first premolar because of the rapidity of development and early emergence of the permanent canine. In boys, on the other hand, impaction of the first premolar is less likely to occur since the permanent canine develops at a slower rate and emerges later than in girls.

The loss of the deciduous mandibular second molar in both boys and girls may result in impaction of the second premolar due to mesial drifting of the permanent first molar.

Discussion

In preventive orthodontics serial extraction is essentially concerned with influencing the eruption of the permanent teeth by extraction of their deciduous predecessors. In pedodontics, the indication for space maintenance has to be defined frequently when deciduous teeth are lost. The data presented attempt to give a better evaluation of these problems.

For optimum results in serial extraction a deciduous tooth should be removed at a time when the permanent successor will emerge without delay. It has been shown in the present study

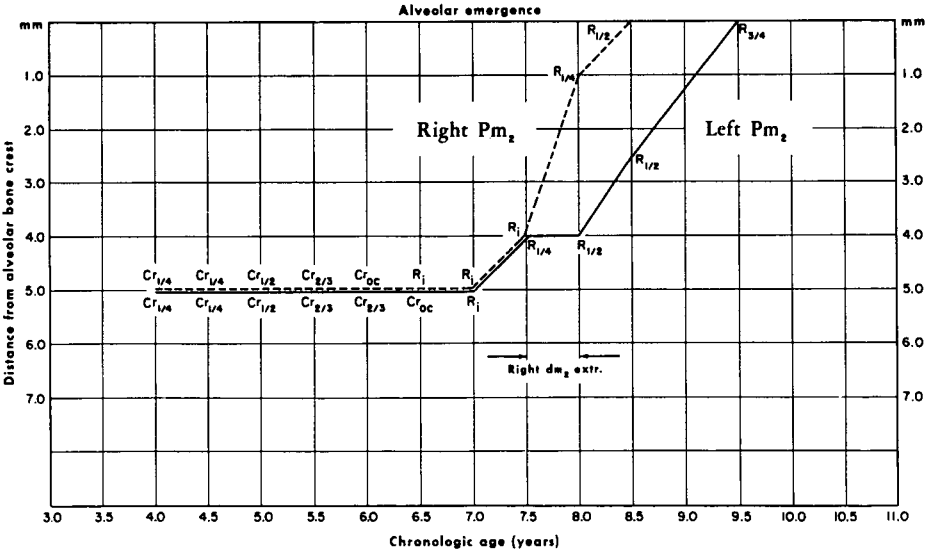

Fig. 3. At 4.0 years the developing left and right second premolars of this boy were situated 5.0 mm beneath the alveolar crest of the mandible and both crowns were one-fourth formed. At 7.0 years of age, when both were at stage "root initial", the left and right second premolars commenced eruption. After abscess and extraction of the deciduous right second molar between 7.5 and 8.0 years of age, the right premolar rapidly erupted 3.0 mm in six months and it emerged through the alveolar crest at 8.5 years when one-half of the root was formed. The left premolar erupted more slowly and alveolar emergence occurred at 9.5 years when the root was three-fourths formed. At 9.5 years of age, the right premolar was impacted and unable to emerge clinically because the mesial drift of the permanent first molar blocked its further movement. Beginning at 6.0 years of age, the development of the left premolar was one stage in advance compared with that of the right premolar.

that extraction of a deciduous molar at any age causes a brief spurt in premolar eruption, but the timing of clinical emergence is not necessarily affected. In fact, early extraction may result in delayed eruption and emergence. Correctly planned extraction at a later period will result in accelerated emergence. The timing of extraction should be based on the developmental stage of the tooth and should coincide with its phase of active eruption.

It has been shown by Grφn[9] that premolars emerge when one-half to three-fourths of their roots are formed but canines have slightly more root formation at emergence. Therefore, a deciduous tooth should not be removed until its permanent successor has an appropriate amount of root formation or at least one-fourth to one-half of the root length.

It is also necessary to consider the ages at which the root stages mentioned are reached, as well as the duration, or interval, between these stages. From longitudinal data of dental development[10] the mean age and standard deviation of attaining the one-fourth, one-half and three-fourth stages of root development in males and females for the canine, first premolar and second premolar are presented in Table II. The average duration of these stages is shown in Table III for the canine and premolars of males and females. This

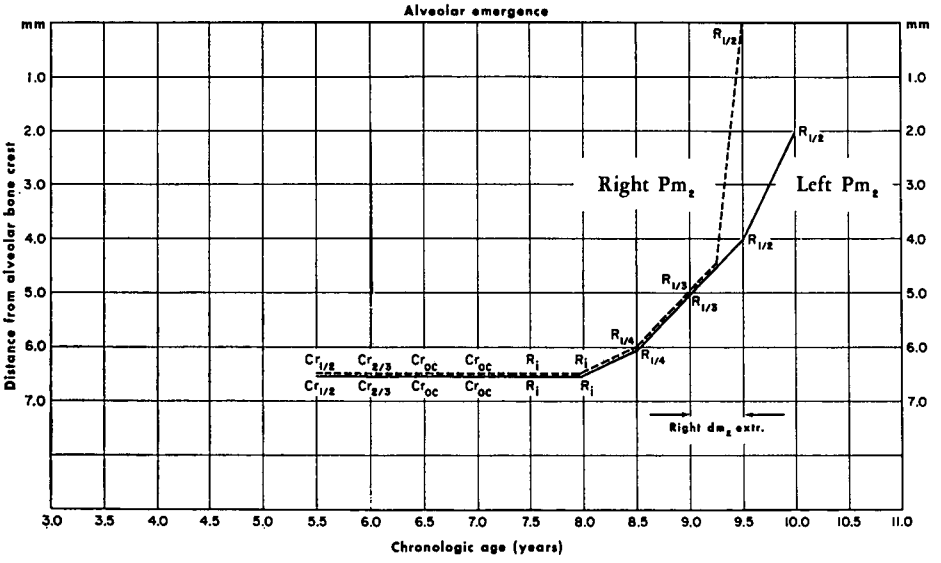

Fig. 4. At 5.5 years of age the developing left and right second premolars of this boy were situated 6.5 mm from the alveolar crest of the mandible and one-half of both crowns was formed. At 7.5 years, root formation commenced and the teeth began to erupt. At 9.0 years both teeth were 5.0 mm from the alveolar crest. Between 9.0 and 9.5 years of age, the right deciduous second molar was extracted and the right premolar moved 5.0 mm in six months emerging through the alveolar crest at 9.5 years when the root was one-half formed. The left premolar erupted more slowly and at 10.0 years of age it was still 2.0 mm below the alveolar crest. The same rate and pattern of tooth formation occurred throughout the observation period in the left and right premolars.

TABLE II

Mean age of attaining various root formation stages

Stage	Sex	Canine Age of attainment Mean Years	Canine Age of attainment Standard Deviation Years	Pm_1 Age of attainment Mean Years	Pm_1 Age of attainment Standard Deviation Years	Pm_2 Age of attainment Mean Years	Pm_2 Age of attainment Standard Deviation Years
Root ¼	M	5.74	0.63	6.88	0.74	7.75	0.83
	F	5.30	0.59	6.49	0.71	7.50	0.80
Root ½	M	8.06	0.86	8.58	0.91	9.39	0.98
	F	7.10	0.76	8.15	0.87	8.79	0.93
Root ¾	M	9.65	1.01	9.94	1.04	10.75	1.11
	F	8.31	0.88	9.20	0.96	10.03	1.04
Root full length open apex	M	10.21	1.07	10.45	1.08	11.61	1.20
	F	8.86	0.93	9.89	1.03	10.70	1.11

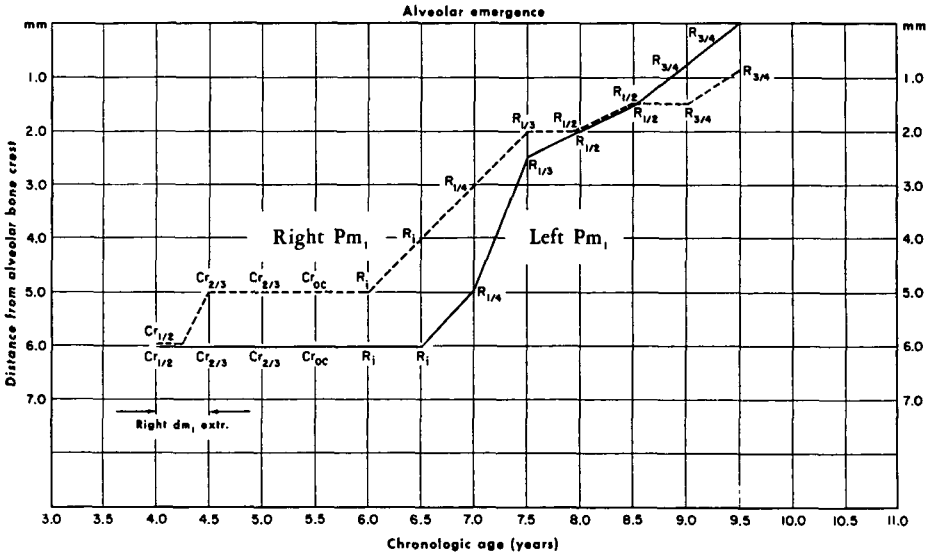

Fig. 5. At 4.0 years of age the developing left and right first premolars of this girl were situated 6.0 mm below the alveolar crest of the mandible and one-half of the crown was formed in both instances. Between 4.0 and 4.5 years of age, the deciduous right first molar was extracted and the right premolar erupted 1.0 mm, but no change occurred in its rate of formation. Both premolars remained stationary thereafter until their roots commenced to develop. At 6.0 years of age, the right premolar at stage "root initial" began eruption and it moved 3.0 mm in 1.5 years. At 7.5 years of age the permanent canine commenced its eruption causing the movement of the right premolar to slow down and to cease eruption for a time. Alveolar emergence of the canine resulted in the premolar remaining 1.0 mm from the alveolar crest, temporarily impacted, with its root three-fourths formed. At 6.5 years, at stage "root initial", the left premolar commenced to erupt. The permanent left canine began eruption at 7.5 years and emerged through the alveolar crest between 8.5 and 9.0 years of age. Between 9.0 and 9.5 years the deciduous left first molar was exfoliated and the premolar emerged through the alveolar crest and also clinically, at 9.5 years, when the root was three-fourths formed. The rate of crown and root formation for both premolars was the same at all ages.

TABLE III

Mean time interval between various stages of root formation

Stage interval	Sex	Canine Mean time interval Years	Pm_1 Mean time interval Years	Pm_2 Mean time interval Years
Root ¼ - ½	M	2.32	1.70	1.64
	F	1.80	1.66	1.29
Root ½ - ¾	M	1.59	1.36	1.36
	F	1.21	1.05	1.24
Root ¾ - root full length open apex	M	0.56	0.51	0.86
	F	0.55	0.69	0.67

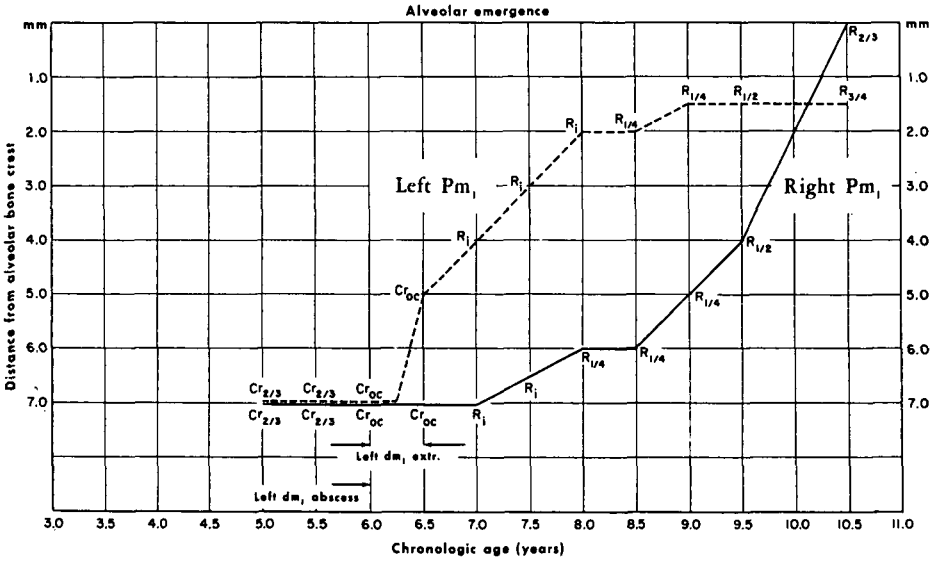

Fig. 6. At 5.0 years of age the developing left and right first premolars of this girl were situated 7.0 mm beneath the alveolar crest of the mandible and both crowns were two-thirds formed. At 5.5 years the deciduous left first molar was abscessed and bone destruction was noted. Between 6.0 and 6.5 years of age, the deciduous left first molar was extracted. No change was seen in the rate of formation of the left premolar. However, a movement of 2.0 mm towards the alveolar crest occurred and the tooth continued to erupt until 8.0 years when the permanent canine commenced its eruption emerging through the alveolar crest at 9.0 years and clinically at 9.5 years. Its presence was responsible for impaction of the premolar which, from 9.0 to 10.5 years, remained 1.5 mm below the alveolar crest. Until 7.0 years of age when root formation was initiated, the right premolar remained 7.0 mm from the alveolar crest. At this time it commenced to erupt and emerged through the alveolar crest at 10.5 years when the root was two-thirds formed. The right deciduous molar was exfoliated at 10.5 years and the right premolar emerged clinically. No difference in root formation was observed between the right and left first premolars following extraction of the deciduous left first molar.

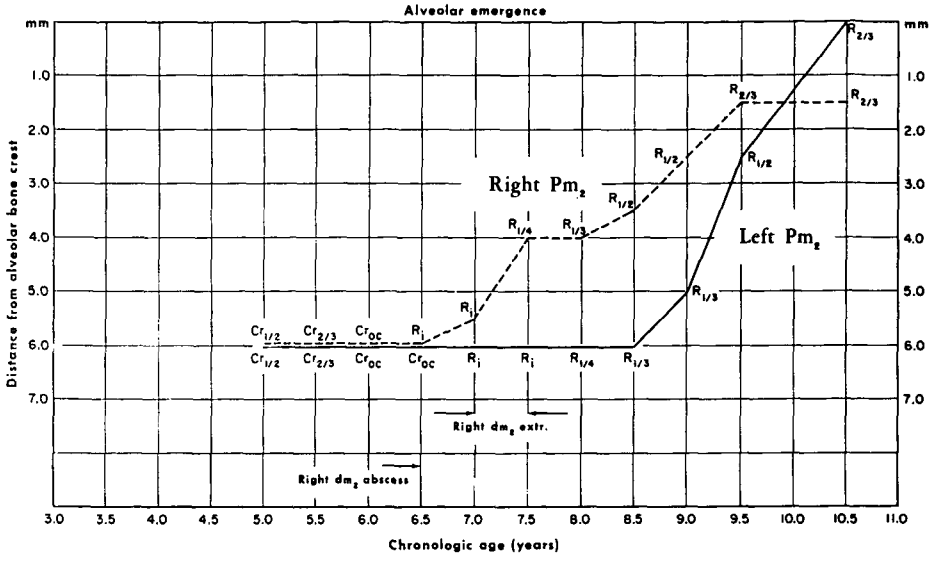

Fig. 7. At 5.0 years of age the developing left and right second premolars of this girl were situated 6.0 mm from the alveolar crest of the mandible and the crowns of both teeth were one-half formed. At 6.5 years the deciduous right second molar was abscessed, the surrounding bone was destroyed, and the right premolar moved upwards 0.5 mm. Between 7.0 and 7.5 years of age the deciduous molar was extracted and the premolar continued to erupt until 9.5 years when its movement ceased because it was impeded by the mesial drift of the permanent first molar. The premolar became impacted when it was 1.5 mm below the alveolar crest with two-thirds of its root formed. The left premolar remained stationary until its root was one-third formed. At 8.5 years it commenced to erupt, emerging through the alveolar crest at 10.5 years when the root was two-thirds formed.

mean interval between the attainment of one-fourth and one-half root stages varies from 1.29 years in the second premolar to 2.32 years in the canine. The duration between the stages of one-half and three-fourths is less, varying from 1.05 to 1.59 years. It is emphasized that the time needed for root formation prior to emergence is longer than generally expected. However, the interval between the stages root three-fourths formed to root with open apex, associated with emergence of the teeth, is shorter, ranging from 0.51 years to 0.86 years.

Another aspect affecting serial extraction and demonstrated in the present study relates to the early maturation and eruption of the permanent mandibular canine in girls. The timing of extraction of the first deciduous molar is especially critical in cases of crowding when the treatment plan calls for the subsequent extraction of the first premolar. If the deciduous tooth is removed too soon, the early erupting permanent canine may cause impaction of the first premolar, thereby defeating the objective of therapy. This situation occurs less frequently in boys where the permanent canine is slower to mature and erupt.

Summary and Conclusion

The results of extraction, at different ages, upon the formation and eruption

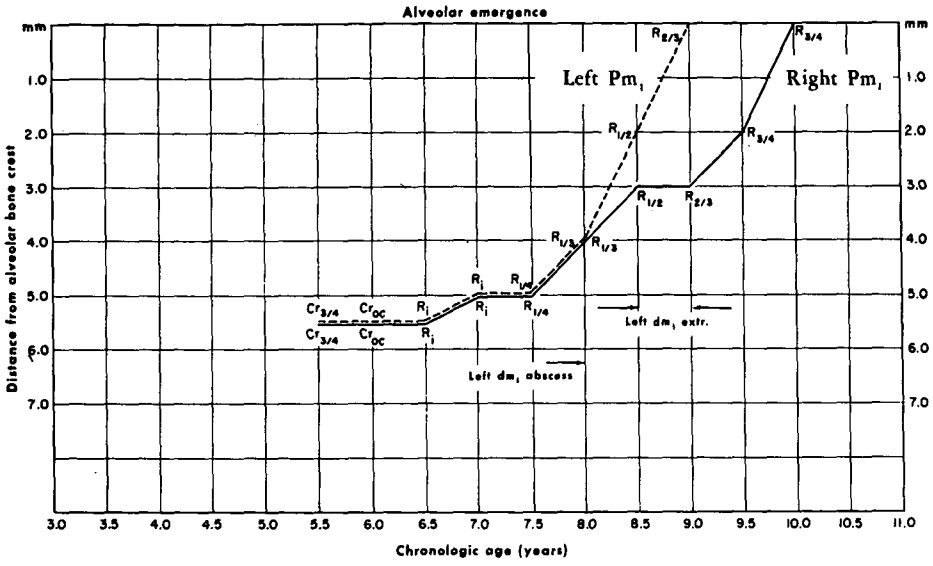

Fig. 8. At 5.5 years of age the developing left and right first premolars of this girl were situated 5.5 mm from the alveolar crest of the mandible and both crowns were three-fourths formed. At 6.5 years when root formation was initial for both premolars, these teeth commenced their eruption. At 8.0 years the deciduous left first molar was abscessed and the surrounding bone destroyed, causing the premolar to move 2.0 mm upwards. Between 8.5 and 9.0 years of age the deciduous left molar was extracted and the premolar rapidly moved through the alveolar crest, emerging clinically at 9.0 years when the root was two-thirds formed. The right premolar erupted more slowly, emerging through the alveolar crest at 10.0 years when three-fourths of its root was formed. No change in the rate of formation of the left premolar after the extraction of its deciduous predecessor was observed in comparison with its antimere.

of the premolar was studied in four boys and four girls. Unilateral extraction of a deciduous molar, utilizing its antimere as a control, made it possible to evaluate changes in the rate of formation as well as the speed and time of eruption of the succedaneous tooth.

No change was observed in the rate of root formation of the premolar after extraction of its deciduous precursor. However, an immediate spurt occurred in the eruption of the premolar, regardless of its stage of development and the age at which the deciduous molar was extracted. Premolar eruption was accelerated in the presence of long-standing necrosis of the deciduous tooth, especially if accompanied by loss of surrounding bone. Similarly, early clinical emergence occurred if the extraction of the deciduous molar coincided with the later period of development of the premolar when it was in active eruption. An initial spurt in the eruption of the premolar followed very early extraction of the deciduous molar, for instance at approximately four years of age, before the crown was formed. This spurt levelled off and the tooth then remained stationary erupting later than its antimere with a normally resorbing deciduous precursor.

The effect of an environmental insult, such as extraction of a deciduous tooth, upon the formation and eruption of its permanent successor, the findings of

Grφn on the amount of root formation at the time of emergence and the age norms for attainment of various stages of root development are three factors that may be applied by the clinician to decide the optimum time for the removal of teeth in preventive orthodontics.

The present study has made possible the compilation of basic facts on dental development that can be obtained only from longitudinal material. The radiographs used are particularly valuable because they are serial, bilateral records of a caries-prone population in the United States.

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