The effect of early loss of primary molars on tooth eruption and space conditions A longitudinal study

ASSAR RÖNNERMAN

Department of Orthodontics, University of Göteborg, Sweden

Rönnerman, A. The effect of early loss of primary molars on tooth eruption and space conditions. A longitudinal study. *Acta Odont. Scand.* 35, 229–239

In 186 children study casts were made at the age of 9, 11 and 13 years. The material was grouped according to early loss of primary molars and a comparison was made between children with and without early losses. Early loss was defined as follows: 1. extraction of the first primary molar between 7 1/2 and 9 1/2 years and/or extraction of the second primary molar between 7 1/2 and 10 1/2 years; 2. extraction of the first and/or second primary molar before 7 1/2 years of age. The following variables were studied: space conditions, dental stage for groups of teeth, eruption stage of single teeth. For the incisors the clinical crown length (CCL) was used as a measure of the eruption stage. The results showed that there was a tendency to later eruption and later onset of dental stages in cases without early losses when a comparison was made with investigations where this factor had not been taken into consideration. The second permanent molar erupted earlier in both jaws after early loss of the second primary molar. Children with loss of primary molars before 7 1/2 years developed more crowding than children without losses and losses after 7 1/2 years had little effect on the relative space.

Key-words: Deciduous; tooth extraction; development

Assar Rönnerman, Department of Orthodontics, University of Göteborg, Fack, S-400 33 Göteborg, Sweden

INTRODUCTION

Early loss of primary molars is followed by early eruption of the first permanent molars (*de Boer*, 1972, 1974; *Rönnerman*, 1974) and a tendency to early eruption of the incisors and the second permanent molars (*Rönnerman*, 1974). The extractions had been performed before the age of 7 years in de Boer's and before 7 1/2 years in Rönnerman's investigation. In the case of canines and premolars, on the other hand, no differences were found between an extraction and a control group (*Rönnerman*, 1974). Nor did *Butler* (1962) find any significant differences in the eruption time for premolars or second permanent molars after early loss of primary molars. *Sleichter* (1963) and *Posen* (1965) found, however, that bicuspid eruption was hastened by early, but retarded by very

Received for publication, February 3, 1977

early extraction of deciduous molars. *MacLaughlin, Fogels & Shiere* (1967) found that 20 % of the succeeding second bicuspids became impacted or erupted ectopically after early loss of the second primary molar.

The mean time for eruption of the permanent dentition and for special dental stages has been presented in a number of reports (*Dahlberg & Maunsbach,* 1948; *Hurme,* 1949; *Lysell, Magnusson & Thilander,* 1969; *Helm,* 1970; *Myllärniemi,* 1970; *Alstad,* 1973; *Helm & Seidler,* 1974; *Magnusson,* 1976). In these investigations the effect on tooth eruption of early loss of primary molars has not been taken into account. The aim of this study was to analyse this problem and to discuss space conditions in the dental arches after early loss of primary molars as the two problems are sometimes closely related.

The material consisted of 186 children (105 boys and 81 girls), previously described by *Rönnerman* (1965); 140 with and 46 without early loss of primary molars. Study casts were made at the age of 9, 11 and 13 years by the author at the dental school clinic where the children reached their dental care. Thus, dental radiographs and case history cards were available.

The following variables were studied:

Time for loss of primary teeth

This was indicated in the following manner:

0 = normal exfoliation (including extraction of the first primary molar after the age of 9 1/2 years and the second primary molar after the age of 10 1/2 years),
1 = extraction of the first primary molar (from 7 1/2 to 9 1/2 years),
2 = extraction of the first and/or second primary molar (before 7 1/2 years).

Space conditions

The relative space in the dental arch was measured in four segments (Fig. 1), and indicated as follows:

0: ≧ – 0.5 mm
1: –0.6 to – 2.0 mm
2: < – 2.0 mm

When the permanent teeth were not erupted a mean value of 22 mm was used in the lateral segment in the maxilla and 21 mm in the mandible.

Dental stages for groups of teeth were registered according to *Björk et al.* (1964) and *Myllärniemi* (1970).

Eruption stage of single teeth. The eruption of the incisors was registered as the clinical crown length (CCL) measured buccaly from the gingival margin to incisal edge of the tooth (Fig. 2).

The canines, premolars or second molars were recorded as: 0 = not visible, 1 = under eruption, 2 = fully erupted. Full eruption was recorded when a tooth was in occlusion. If the antagonist was not fully erupted assessment was done in relation to a theoretical occlusion curve.

STATISTICAL METHODS

A non parametric correlation analysis based on Fisher's permutation test (*Odén & Wedel,* 1975) was performed in order to investigate the effect of loss of primary molars. Each of the eight molars were separately analysed. When a molar was analysed, the subjects that were equal with respect to loss of the other molar of the same quadrant formed a group. Within every such group the effect of a loss of the considered molar was determined by Fisher's test variable. The results from the different groups then were pooled to a summarizing test. Thereby the influence of the neighbouring molar was eliminated. Sex differences regarding clinical crown length was tested by t-test.

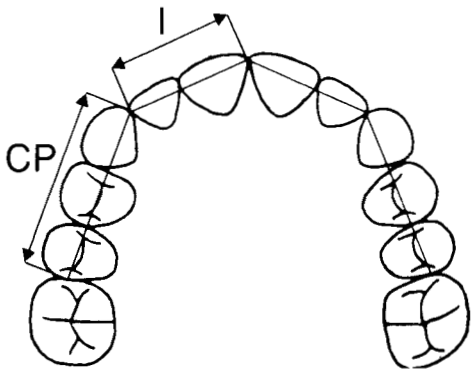

Fig. 1. Segments measured on the dental casts. Incisor segment (I) and Canine-Premolar segment (CP).

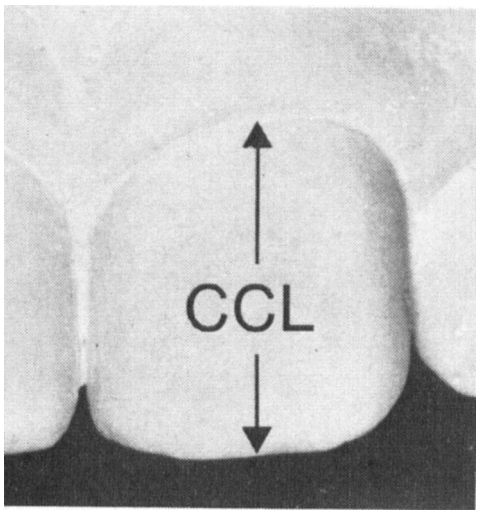

Fig. 2. The arrows indicate the measuring points for the clinical crown length (CCL).

RESULTS

The distribution of loss of primary molars is shown in Table I. Before 7 1/2 years the first primary molar had been lost more than twice as often from the mandible as from the maxilla (26 % and 11 %, respectively). At the same time the second primary molar had been extracted about four times as often from the mandible (29 %) as from the maxilla (7 %).

Extractions performed after 7 1/2 years were as frequent in the maxilla as in the mandible. The second primary molar had been lost twice as often as the first primary molar.

Space conditions in children *without* early loss of primary molars are shown in Table II. The space in the incisor segments increased with age, while it decreased in the lateral segments. For example, at the age of 9 years 36 % of the boys had crowding (more than 0.5 mm) in the maxilla, while at 13 years the frequenxy was 6 %. For the lateral segments the figures were 4.5 % at 9 years and 16.4 % at 13 years. The *effect of early loss of primary molars* on relative space can be seen in Table VI. It is clear that children with loss of primary teeth before 7 1/2 years developed more crowding than children without losses, and that loss of primary teeth after 7 1/2 years had very little effect on relative space.

The dental stage for groups of teeth (Björk et al. 1964 and *Myllärniemi* 1970) in children *without* early loss of primary molars are shown in Table III.

The clinical crown length (CCL) for incisors in children without early loss of primary molars is presented in Table IV. The increase was most pronounced for the maxillary laterals. For boys they increased from 4.1 mm at the first registration (age 8.9 years) to 7.8 mm at the third registration (age 12.9 years). The corresponding figures for girls were 5.2 mm and 7.5 mm. Girls showed longer clinical crown length than boys for upper laterals at the age of 8.9 years ($P<0.05$) while boys had longer clinical crown length for the same teeth at the age of 10.9 ($P<0,01$) and at the age of 12.9 years ($P<0.05$). Boys also showed longer clinical crown length than girls for upper centrals at the age of 10.9 and 12.9 years ($P<0.01$). Table VI shows that children with early loss of the first deciduous molar exhibited a longer clinical crown (the upper right central incisor excluded) than those without early loss. Children with loss of the upper left second primary molar exhibited a shorter central incisor in this quadrant.

The eruption stages of canines, premolars and second molars in children *wihtout* early

Table I. *Distribution in per cent of loss of primary molars in 186 children.*

Time for loss	Maxilla				Mandible			
	First		Second		First		Second	
	right	left	right	left	right	left	right	left
0	77	78	71	70	64	65	52	50
1	11	11	21	23	11	9	18	22
2	12	11	8	7	25	26	30	28

0 = normal exfoliation
1 = extraction of the first primary molar (7 1/2 to 9 1/2 years of age) and the second primary molar (7 1/2 to 10 1/2 years of age)
2 = extractions before the age of 7 1/2 years

Table II. *Relative space in quadrants without early loss of primary molars. Number and percentage*

	Incisor segments					Lateral segments				
Boys	REC	0	1	2	PCT 1 & 2	REC	0	1	2	PCT 1 & 2
T1	110	70	36	4	*36.4*	110	105	5	0	*4.5*
Upper jaw T2	134	117	15	2	*12.7*	134	121	8	5	*9.7*
T3	134	126	7	1	*6.0*	134	112	13	9	*16.4*
T1	61	53	8	0	*13.1*	61	61	0	0	*0.0*
Lower jaw T2	83	77	6	0	*7.2*	83	81	2	0	*2.4*
T3	83	79	4	0	*4.8*	83	78	5	0	*6.0*
Girls										
T1	75	57	12	6	*24.0*	75	67	2	6	*10.7*
Upper jaw T2	89	78	7	4	*12.4*	88	79	4	5	*10.2*
T3	89	81	6	2	*9.0*	88	75	5	8	*14.8*
T1	53	43	9	1	*19.0*	53	53	0	0	*0.0*
Lower jaw T2	67	59	7	1	*11.9*	67	64	3	0	*4.5*
T3	67	57	10	0	*15.0*	68	64	3	1	*5.9*

0 = $\geqslant -0.5$
1 = $-0.6 \rightarrow -2.0$
2 = < -2.0
T1 = age 8.9 T2 = age 10.9 T3 = age 12.9 (registration times)
REC = number of recordable quadrants
N = absolute frequency
PCT = percentage frequency

Table III. *Dental stages for boys and girls according to Björk et al. and Myllärniemi in children without early loss of primary molars. Number and percentage.*

		DS BJÖRK et al. Anterior to molars					DS BJÖRK Molars			DS MYLLÄRNIEMI					
		n	1	2	3	4	n	1	2	n	3	4	5	6	7
Boys	T1	17	11 *64.7*	5 *29.4*	1 *5.9*	0	17	17 *100.0*	0 *0.0*	17	6 *35.3*	10 *58.8*	1 *5.9*	0 *0.0*	0 *0.0*
	T2	28	0	10 *35.7*	17 *60.7*	1 *3.6*	28	28 *100.0*	0 *0.0*	28	0 *0.0*	10 *35.7*	17 *60.7*	0 *0.0*	1 *3.6*
	T3	28	0 *0.0*	0 *0.0*	18 *64.3*	10 *35.7*	28	22 *78.6*	6 *21.4*	28	0 *0.0*	0 *0.0*	13 *46.4*	7 *25.0*	8 *28.6*
Girls	T1	11	4 *36.4*	4 *36.4*	3 *27.3*	0 *0.0*	11	11 *100.0*	0 *0.0*	11	3 *27.3*	5 *45.5*	3 *27.3*	0 *0.0*	0 *0.0*
	T2	18	2 *11.1*	1 *5.6*	15 *83.3*	0 *0.0*	18	18 *100.0*	0 *0.0*	17	1 *5.9*	2 *11.8*	10 *58.8*	3 *17.6*	1 *5.9*
	T3	17	0 *0.0*	0 *0.0*	6 *35.3*	11 *64.7*	17	7 *41.2*	10 *58.8*	17	0 *0.0*	0 *0.0*	5 *29.4*	0 *0.0*	12 *70.6*

Dental stages according to Björk et al.
Teeth anterior to the molars
1 = incisors erupting
2 = incisors fully erupted
3 = canines or premolars erupting
4 = canines and premolars fully erupted
Molars
1 = first molars fully erupted
2 = second molars fully erupted
Dental stages according to Myllärniemi
3 = incisors erupting
4 = all eight permanent incisors and four first molars erupted
5 = canines or premolars erupting
6 = all permanent teeth anterior to second molars erupted
7 = 28 permanent teeth erupted

T1 = age 8.9 T2 = age 10.9 T3 = age 12.9 (registration times)

Table IV. *Clinical crown length (CCL) in mm for incisor teeth in quadrants without early loss of primary molars.*

	Age 8.9 years						Age 10.9 years						Age 12.9 years					
	BOYS			GIRLS			BOYS			GIRLS			BOYS			GIRLS		
	n	M	sd	n	M	sd	n	M	sd	n	M	sd	n	M	sd	n	M	sd
upper laterals	108	4.1	3.14	75	5.2	2.54	131	7.3	0.80	86	6.9	1.05	132	7.8	0.75	86	7.5	0.70
upper centrals	109	8.0	1.40	74	8.0	1.49	127	9.2	0.85	88	8.9	0.30	125	9.6	0.80	86	9.2	0.85
lower laterals	58	6.0	1.89	52	6.3	1.36	79	7.3	0.70	65	7.3	0.76	80	7.8	0.65	62	7.8	0.81
lower centrals	58	7.3	0.74	51	7.4	0.80	80	7.7	0.64	64	7.7	0.70	79	7.6	0.65	63	7.7	0.71

Table V. *Tooth eruption stage in quadrants without early loss of primary molars. Number and percentage.*

		T1				T2				T3			
			N		PCT		N		PCT		N		PCT
	Teeth	REC	1	2	1+2	REC	1	2	1+2	REC	1	2	1+2
Boys	17.27	110	0	0	*0.0*	133	8	2	*7.5*	134	21	45	*49.3*
	15.25	110	1	0	*0.9*	134	14	12	*19.4*	134	24	82	*79.1*
	14.24	110	2	1	*2.7*	134	33	20	*39.5*	132	20	105	*94.1*
	13.23	110	2	1	*2.7*	134	21	3	*17.9*	134	54	60	*85.1*
	47.37	61	0	0	*0.0*	83	3	1	*4.8*	83	21	38	*71.1*
	45.35	61	0	0	*0.0*	83	9	7	*19.3*	83	11	59	*84.3*
	44.34	61	2	0	*3.3*	83	25	10	*42.2*	83	18	63	*97.6*
	43.33	61	2	0	*3.3*	83	33	8	*49.4*	83	15	65	*96.4*
Girls	17.27	75	0	0	*0.0*	89	16	1	*19.1*	87	14	57	*81.6*
	15.25	75	0	0	*0.0*	89	18	24	*47.2*	87	5	73	*89.7*
	14.24	75	5	0	*6.7*	89	18	44	*69.7*	86	7	75	*95.3*
	13.23	75	6	0	*8.0*	89	32	19	*57.3*	86	16	59	*87.2*
	47.37	53	0	0	*0.0*	67	7	5	*17.9*	66	6	50	*84.8*
	45.35	53	1	0	*1.9*	67	14	21	*52.2*	66	4	56	*90.9*
	44.34	53	5	1	*11.3*	67	18	30	*71.6*	66	5	60	*98.5*
	43.33	53	15	0	*28.3*	66	17	38	*83.3*	66	1	63	*97.0*

REC = number of recordable quadrants
N = absolute frequency
PCT = percentage frequency
1 = tooth under eruption
2 = tooth fully erupted

T1 = age 8.9 T2 = 10.9 T3 = age 12.9 (registration times)

Text to Table VI

Q1 = upper right quadrant
Q2 = upper left quadrant
Q3 = lower left quadrant
Q4 = lower right quadrant
CCL1 = clinical crown length for tooth number 1
CCL = clinical crown length for tooth number 2 in the quadrant in question.
T1 = age 8.9 T2 = age 10.9 T3 = age 12.9 (registration times). x = significance at the 5 % level,
xx = significance at the 1 % level.
+ denotes that the first group has significantly more space in lateral segments longer CCL, more erupted successors and more erupted second molars.
– denotes that the second group has significantly more space in lateral segments longer CCL, more erupted successors and more erupted second molars.

Table VI. *Effect of loss of one primary molar when the effect of the other in the quadrant in question was eliminated. See statistical methods. For legends see oposite side.*

	First group	Second group		Relative space lateral segment				CCL1				CCL2				Eruption stage successor				Eruption stage second molar			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
First primary molar	No loss	Loss before 9 1/2 years (totals)	T1	+xx	+x	+xx	+xx		−xx	−x			−x			−xx	−xx						
			T2	+x		+x	+x		−xx	−xx	−xx			−x	−x		−x						
			T3			+x			−x	−x	−x	−x			−x				+x	−x			
	No loss	Loss between 7 1/2 and 9 1/2 years	T1						−x					−x	−x	−xx	−xx		−xx				
			T2						−x			−x				−x	−x		−xx				
			T3						−x			−xx											
	No loss	Loss before 7 1/2 years	T1	+xx	+xx	+xx	+xx		−x	−x	−x						−xx						
			T2	+xx	+x		+x			−x								+xx					
			T3	+x		+xx					−xx								+xx	−x			
	Loss between 7 1/2 and 9 1/2 years	Loss before 7 1/2 years	T1																+xx				
			T2	+x												+x			+xx				
			T3	+x								+x							+x				
Second primary molar	No loss	Loss before 10 1/2 years (totals)	T1	+xx	+x	+xx	+xx		+x							−x	−xx		−x				
			T2	+xx	+xx	+xx	+xx									−xx	−xx	−x			−x	−xx	−xx
			T3	+x		+xx	+xx												+x		−x		
	No loss	Loss between 7 1/2 and 10 1/2 years	T1	+x			+x										−xx		−x				
			T2	+xx			+xx		+xx							−xx	−xx	−xx			−xx	−x	−x
			T3						+x														
	No loss	Loss before 7 1/2 years	T1	+xx	+xx	+xx	+xx										−x		+x			−x	
			T2	+xx	+xx	+xx	+xx											+xx	+xx				
			T3	+x	+x	+xx	+xx														−x	−x	−x
	Loss between 7 1/2 and 10 1/2 years	Loss before 7 1/2 years	T1	+x	+xx	+xx	+xx																
			T2		+xx	+x	+x											+xx	+xx				
			T3		+x													+x	+x				

loss of primary molars are given in Table V. At the age of 8.9 years no second molars had emerged. The only second premolars visible at this time were one in the maxilla in a boy and one in the mandible in a girl. At the age of 10.8 years the percentage of emergence for the boys varied between 4.8 per cent for the lower second molar and 49.4 per cent for the lower canine. The corresponding figures for girls were 17.9 and 83.3 per cent. At the age of 12.9 years the upper second molar had the lowest eruption value (49.3 per cent for the boys and 81.6 per cent for the girls). The highest value was found among the lower canines and first premolars (about 97 per cent for the boys and 98 per cent for the girls).

After extraction of the first primary molar in the maxilla (Table VI) the eruption of the first bicuspid was hastened. The same condition prevailed for the second bicuspid after early loss of the second primary molar. In the mandible the eruption of the first bicuspid was hastened when the loss of the first primary molar had occurred after 7 1/2 years but retarded if the extraction had been performed before that age. The second bicuspid had the same eruption pattern after early loss of the second primary molar. The second permanent molar erupted earlier in both jaws after early loss of the second primary molar.

DISCUSSION

The reason for choosing the age of 7 1/2 years as criterion for early loss of primary molars was that the children's first visit to the school dentist took place when they were between seven and eight years old and a case history card was filled in at that time. At the first registration (8.9 years) some, though few, of the extractions of primary molars have been registered despite not having been performed. This means that any differences at that time between children with and without early loss of primary molars would have been more pronounced without this overregistration.

The use of an average lateral segment length of 22 mm in the maxilla and 21 mm in the mandible when the permanent teeth are not erupted is an indistinct method. At the last registration, however, if a permanent tooth was not erupted its contralateral usually was and a true value for the relative space could be calculated. Losses of primary canines have not been taken into consideration as they have been extracted for orthodontic reasons. Extractions of primary canines may have influenced space conditions in such a manner that crowding in an incisor segment may have been replaced by crowding in a lateral segment between two registrations.

The space conditions in the incisor segments improved with age in children without extractions in the maxilla due to a normal increase in transversal dimension (*Moorrees & Chadha*, 1965). The boys had more crowding in the maxillary incisor segments than girls at the first registration, reflecting the difference in physiological age at this time. The difference had disappeared at the last registration. Space in the lateral segments was markedly diminished after early loss of primary molars before 7 1/2 years, which is in agreement with earlier findings (*Siersbaek-Nielsen & Helm*, 1973; *Rönnerman*, 1974; *Høffding*, 1976). Losses that occurred after 7 1/2 years, on the other hand, had little influence on space conditions, in accordance with results reported by *Lundström* (1944) and *Linder-Aronson* (1960).

When a comparison is made for the lateral segments between *Helm's* (1970) findings and those of this investigation one finds that the crowding is more or less the same at the first registration (about 9 years), while it differs later on. The most striking differences are to be seen in the mandible, where *Helm* reported 22 % crowding in DS4 and *Rönnerman* found practically no crowding at the age of 12.9 years. The difference can be explained by the fact that *Helm's* result at the first registration (DS2) was based on segments with a full complement of teeth while the registrations in DS3 and DS4 included children with previous extractions of deciduous teeth.

Siersbaek-Nielsen & Helm (1973) reported crowding in lateral segments in children without early loss of primary molars to the same extension as in this investigation, while Myllärniemi (1970) found crowding in the permanent dentition two to three times as often. Early loss of deciduous molars had not been taken into consideration in her material. In children with unilateral losses *Rönnerman & Thilander* (1977) found less space in the lateral segments on the extraction side than on the control side if the second primary molar had been lost early.

The results of determinations of tooth eruption stage in children without early loss of primary molars seem to differ somewhat from those obtained by *Helm & Seidler* (1974). As a whole, there is a tendency to later eruption and later onset of dental stages in the present investigation (Fig. 3), and this difference may be explained by the effect of early loss of primary molars.

Table VI shows that for the mandible it is clear that the eruption of the succeeding teeth was hastened if losses occurred after 7 1/2 years of age, but was retarded if losses occurred before that age. The retardation could not be demonstrated in the maxilla, probably owing to too few quadrants with losses of second primary molars before 7 1/2 years.

The clinical crown length (CCL) has been used as a measure of the eruption stage of a single incisor. The method can be afflicted with some uncertainty due to gingival conditions and attrition. At the ages investigated here none of these factors is of great importance and the method therefore provides a possibility of registering alterations in the incisor segments when comparing different groups. In children without early loss it was found that the clinical crown length for the upper laterals at the age of 8.9 years was shorter in boys than in girls and the centrals were of equal length, due to greater physiological maturation among girls at this age (*Lysell, Magnusson & Thilander*, 1969). At the ages of 10.9 and 12.9 years, on the other hand, the clinical crowns for both laterals and centrals were longer in boys than in girls, which may perhaps be regarded as normal. *Seipel* (1946) found the same regarding centrals.

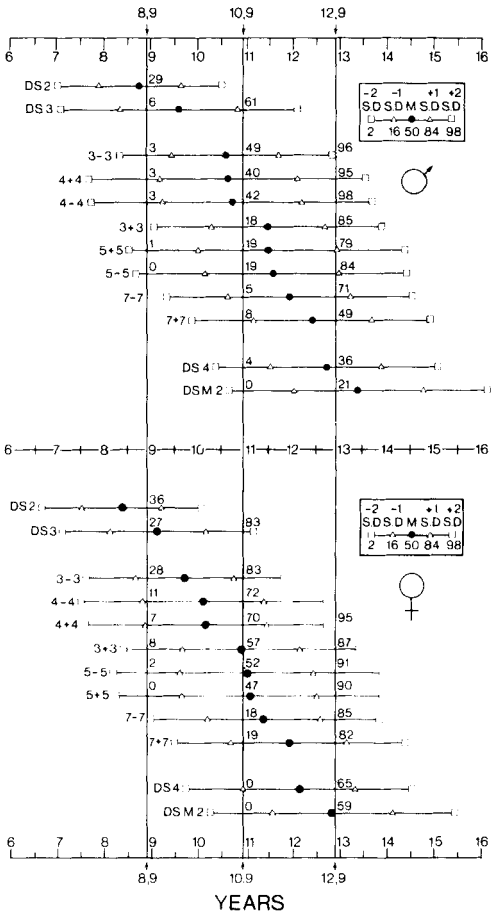

Fig. 3. Tooth emergence and onset of dental stages. A comparison between *Helm & Seidler* (1974) and *Rönnerman* (present study). The figures where the vertical and horisontal lines intersect represent erupted teeth and dental stages in per cent found by Rönnerman. The Haderup system of dental designation is used: + signifies maxillary teeth, – mandibular teeth. Abbreviations of dental stages (DS) according to *Björk et al.* (1964).

Children with losses (Table VI) showed longer clinical crowns after loss of the first primary molar and this effect may be due to a

distal migration of the anterior teeth, giving more room for eruption. Significantly shorter upper left central incisors were also found after loss of the second primary molar in the quadrant in question. This finding is difficult to explain and may be accidental, because it was found only in one quadrant.

From this investigation it can be concluded that early loss of primary molars has an effect on the development of the dentition in many ways. Besides crowding, it is a source of changes in onset of dental stages for groups of teeth and for eruption time of single teeth. Most investigations dealing with these aspects have not taken early loss of primary molars into consideration. This has probably been due to the fact that early losses have been so common that they have been regarded as a normal situation. With increased prophylactic dental care in preschool children early losses are now more rare as has been reported by e.g. *Göland et al.*, 1976 and *Janson & Petterson*, 1976. Epidemiological investigations dealing with dental development and the need for orthodontic treatment in children without early loss of primary molars are therefore desirable.

Acknowledgements. This study was supported by grants from the University of Göteborg and The Swedish Dental Society.

REFERENCES

Alstad, S. 1973. Aldersvariasjoner i tennenes erupsjon hos norske skolebarn. Nor. Tannlægeforen. Tid. 83, 42–48

Björk, A., Krebs, B. & Solow, B. 1964. A method for epidemiological registration of malocclusion. Acta Odont. Scand. 22, 27–41

Butler, D. J. 1962. The eruption of teeth and its association with early loss of the deciduous teeth. Br. Dent. J. 112, 443–449

de Boer, M. 1972. Aspects of the dental development in children at ages ranging between five and ten. Int. J. Orthod. 10, 53–63

de Boer, M. 1974. Time and order of eruption of the first permanent molars and permanent incisors. Netherlands Dent. J. Suppl. 10, 32–81

Dahlberg, G. & Maunsbach, A. B. 1948. The eruption of the permanent teeth in the normal population of Sweden. Acta Genet. et Statistica Med. 1, 77–91

Göland, U., Kock, G., Paulander, J. & Rasmusson, C. G. 1976. Tandhälsotillståndet hos 1000 personer i åldrarna 3 till 70 år inom Jönköpings kommun. IV. Vårdinsatsens inverkan på tandstatus hos förskolebarn. Tandläk. Tidn. 68, 1276–1279

Helm, S. 1970. *Prevalence of malocclusion in relation to development of the dentition.* Acta Odont. Scand. 28, Suppl 58, pp 66–77

Helm, S. & Seidler, B. 1974. Timing of permanent tooth emergence in Danish children. Community Dent. Oral Epidemiol. 2, 122–129

Hurme, V. O. 1949. Ranges of normalcy in the eruption of permanent teeth. J. Dent. Child. 16, 11–15

Høffding, J. 1976. Tidligt tab af primære tænder. Følger for den sagittale okklusion og pladsforholdene i det permanente tandsæt. Afhandling Københavns Tandlægehøjskole, Instituttet for Pædodonti

Janson, L. & Petterson, E. 1976. Förskoletandvårdens utveckling vid en distriktstandpoliklinik. Tandläk. Tidn. 68, 1281–1284

Linder-Aronson, S. 1960. The effect of premature loss of deciduous teeth. A biometric study in 14- and 15-year olds. Acta Odont. Scand. 18, 101–122

Lundström, A. 1944. Förtidiga mjölktandsförluster och tandställningen. Sven. Tandläk. Tidskr. 37, 698–727

Lysell, L., Magnusson, B. & Thilander, B. 1969. Relations between the times of eruption of primary and permanent teeth. A longitudinal study. Acta Odont. Scand. 27, 271–281

Maclaughlin, J. A., Fogels, H. P. & Shiere, F. R. 1967. The influence of premature primary molar extraction on bicuspid eruption. J. Dent. Child. 34, 399–405

Magnusson, T. E. 1976. Emergence of permanent teeth and onset of dental stages in the population of Iceland. Community Dent. Oral Epidemiol. 4, 30–37

Moorrees, C. F. A. & Chadha, J. M. 1965. Available space for the incisors during dental development. A growth study based on physiologic age. Angle Orthod. 35, 12–22

Myllärniemi, S. 1970. *Malocclusion in Finnish rural children. An epidemiological study of different stages of dental development.* Academic Diss. Forssa, Helsinki, pp 16–20, 32

Odén, A. & Wedel, H. 1975. Arguments for Fischer's permutation test. Ann. Stat. 3, 518–520

Posen, A. L. 1965. The effect of premature loss of deciduous molars on premolar eruption. Angle Orthod. 35, 249–252

Rönnerman, A. 1965. *Early extraction of deciduous molars and canines. Its incidence and influence on spacing.* Trans. Europ. Orth. Soc., pp 153–168

Rönnerman, A. 1974. Early extraction of deciduous molars. Effect on dental development and need of orthodontic treatment. Sven. Tandläk. Tidskr. 67, 327–337

Rönnerman, A. & Thilander, B. 1977. The effect of unilateral extraction of primary molars. A longitudinal study. Scand. J. Dent. Res. 85, 362–372

Schleichter, C. G. 1963. The influence of premature loss of deciduous molars and the eruption of their successors. Angle Orthod. 33, 279–283

Seipel, C. M. 1946. *Variation of tooth position. A metric study of variation and adaptation in the deciduous and permanent dentition.* Sven. Tandläk. Tidskr. 39, Suppl., Håkan Ohlssons Boktryckeri, Lund, p 51

Siersbaek-Nielsen, S. & Helm, S. 1973. Trangstilling i den permanente dentition efter tidligt tab av temporære molarer og hjørnetænder. Tandlægebladet 77, 600–610