European Journal of Orthodontics 22 (2000) 245–255

The long-term survival of lower second primary molars in subjects with agenesis of the premolars

Krister Bjerklin and John Bennett
Department of Orthodontics, Institute for Postgraduate Dental Education, Sweden and Private Practice, London, UK

SUMMARY This study investigated 41 subjects, 13 male and 28 female, with agenesis of one or both lower second premolars, and with retained lower second primary molars. Intra-oral radiographs of 59 primary teeth were examined to judge the resorption of the mesial and distal roots, and were measured to record infra-occlusion of the primary teeth and tipping of the adjacent permanent teeth. The study commenced at 11–12 years of age. The mean age at the last measurement was 20 years 6 months (SD 3.62, range 13.6–31.8 years).

During the observation period, only two of the 59 primary teeth were exfoliated. Five were extracted, two of which were replaced by upper third molar transplants. Beyond the age of 20 years no teeth were lost. Root resorption varied widely between individuals, but was slow. There was no typical pattern for development of infra-occlusion. Mean infra-occlusion was 0.47 mm (SD 1.13) at 11–12 years, increasing by less than 1.0 to 1.43 mm (SD 1.13) at age 17–18 years. At age 19–20 years, 55 per cent of teeth showed infra-occlusion between 0.5 and 4.5 mm, but 45 per cent showed no infra-occlusion. The space between the first molar and first premolar was a mean of 10.35 mm (SD 0.76) at age 10–12 years compared with the mean width of the second primary molar of 10.53 mm (SD 0.51). The space reduced by less than 0.5 mm to 9.95 mm (SD 1.50) at age 17–18 years. If primary molars are present at 20 years of age they appear to have a good prognosis for long-term survival.

Introduction

In many populations it has been reported that, except for third molars, the most commonly missing teeth are lower second premolars (Ravn and Nielsen, 1973; Thilander and Myrberg, 1973; Bergström, 1977; Locht, 1980). In a group of 1006 Swedish children it was found that 2.8 per cent showed agenesis of at least one lower second premolar (Grahnén, 1956). Bergström (1977) established the frequency of hypodontia for 2589 children 8–9 years of age. The number of children with hypodontia of one or both lower second premolars was 143 and hypodontia occurred with bilateral symmetry in 60 per cent of the subjects examined. This represents agenesis of lower second premolars in about 3.3 per cent of the subjects. This is a condition that is frequently encountered during orthodontic treatment planning. The diagnosis may be made after the age of 9 to 10 years (Wisth *et al*., 1974; Steffensen, 1981). In clearly crowded cases, the missing premolar may be used as an extraction space. The lower second primary molar can be extracted, and the space used to relieve crowding or retract anterior teeth, or both. If the extraction decision can be made early, for instance at 11 years of age, before eruption of the second permanent molar, good spontaneous improvement often occurs (Figure 1). Joondeph and McNeill (1971) recommended early extraction of the deciduous molar in cases of hypodontia to permit acceptable spontaneous space closure. Extraction of the primary molar after completed root development of the adjacent teeth often leads to more tipping of these teeth (Lindqvist, 1980).

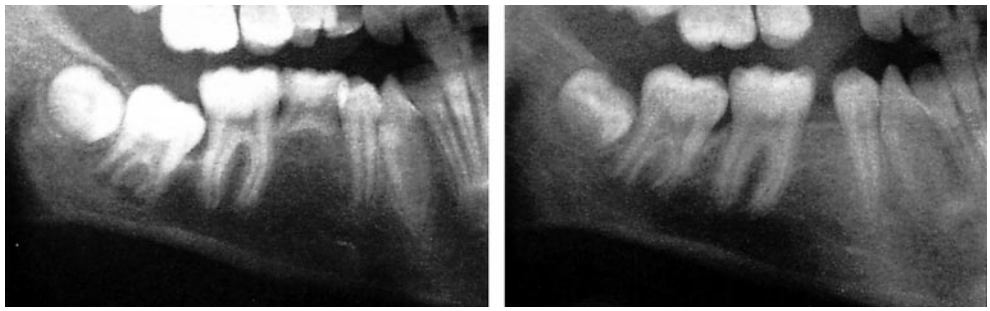

Figure 1 In this subject with crowding it was decided to extract the lower second primary molar at 11 years of age. One year later good spontaneous improvement had occurred.

In uncrowded cases, the treatment planning decisions at age 12 are more difficult. If substantial infra-occlusion of the primary tooth has occurred (Kurol and Thilander, 1984), or if there is root resorption or caries damage, it may be necessary to extract the primary tooth and accept a 7-mm space. The missing premolar can be replaced with a bridge, an implant, or by transplantation of a maxillary third molar (Lundberg and Isaksson, 1996). A fixed prosthesis or implant may, however, impede the growth of the alveolar process (Ödman *et al*., 1991; Zuccati, 1993).

Extraction of lower second primary molars that are in good condition, in an uncrowded patient, followed by attempts at space closure, is often a mistake, especially in low angle subjects. There is difficulty in closing spaces in such cases without adversely affecting the facial profile.

Therefore, in non-crowded subjects with agenesis of one or both lower second premolars, it may be logical to leave the primary second molars *in situ*, but with the risk of infra-occlusion or progressive root resorption, which may lead to eventual extraction, in which case it may be replaced with an autotransplanted upper third molar (Figure 2) or by an implant.

Infra-occlusion or submergence was described by Rune (1971) as 'teeth which fail to maintain their position at the level of the other teeth in the dental arch'. Kurol (1981) described infra-occlusion as 'when the occlusal surface of the primary molar is more than 1 mm below the occlusal plane of fully erupted neighbouring teeth'.

Rune and Sarnäs (1984) reported from subjects with a mean age of approximately 17 years at the last registrations, that of four resorption stages, on average each resorption stage lasted about 4 years.

However, there is a lack of published information concerning long-term survival of lower second primary molars and it is not possible to accurately answer the typical question from the patient: 'How long is the lower primary tooth going to survive if we decide to leave it *in situ*, and what is the probability of root resorption or infra-occlusion?'

The aim of this study was to undertake a long-term follow-up of 41 patients with agenesis of one or both lower second premolars and with the second primary molar present. The registrations focused on the percentage of teeth that remained in the mouth, and the amount of root resorption, infra-occlusion, and tipping of the adjacent teeth.

Subjects and methods

The subjects consisted of 41 children, 13 boys and 28 girls who had previously been diagnosed with agenesis of one or both second premolars in the lower arch. For various reasons, e.g. if the children or the parents refused extractions or orthodontic treatment, the decision was made to leave the primary molars in the arch.

The children had no or very little crowding in the lower arch. The primary molars were monitored by the school dentist at 1-year to 18-month intervals with intra-oral radiographs at the regular

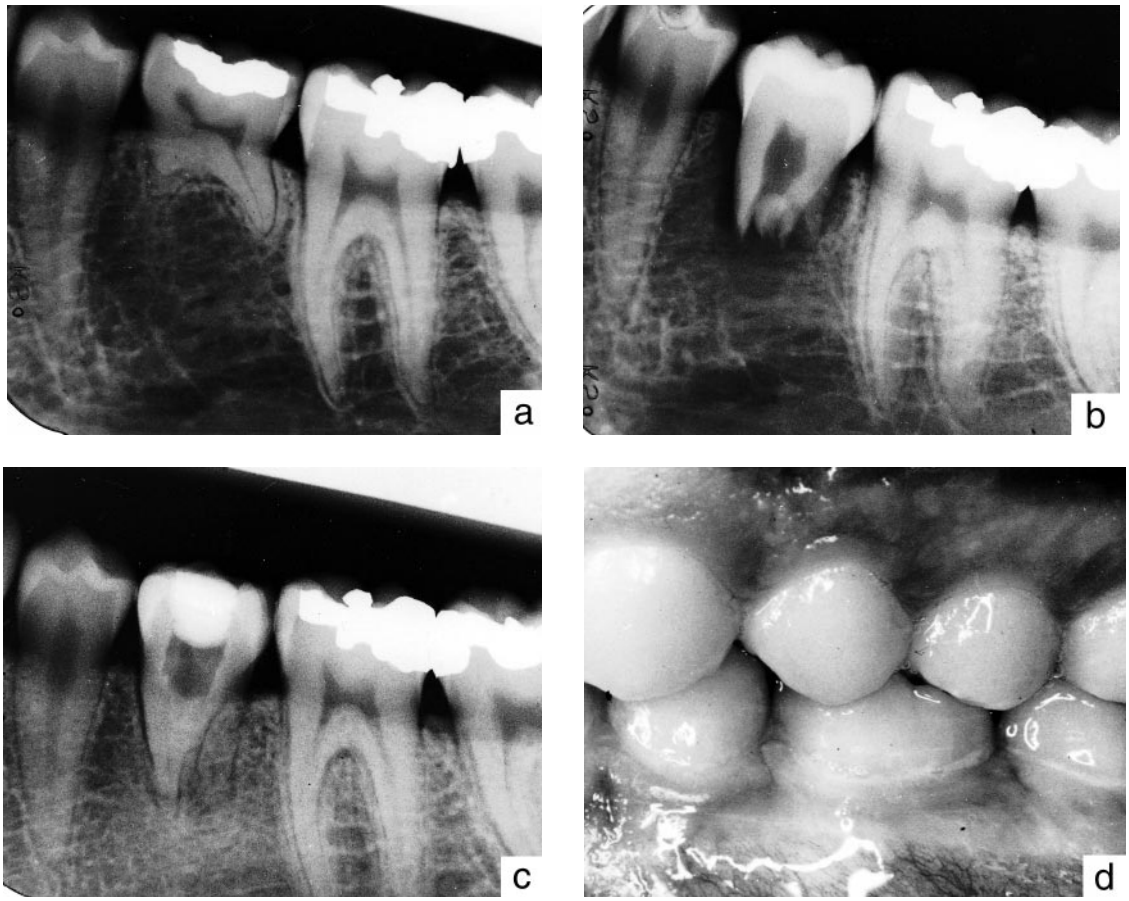

Figure 2 Sequential radiographs of a patient aged 19 years (a,b) and 24 years (c,d). At age 19 the lower right second primary molar was extracted and the upper right third molar was transplanted into the site. A good occlusion was achieved (d).

Table 1 Distribution of the original 59 teeth at the different registration stages, showing the age at registration.

Age years	11–12	13–14	15–16	17–18	19–20	21–22	23–24	25–29	30+
Registration stage	1	2	3	4	5	6	7	8	9
Number of teeth	59	59	58	55	40	20	16	5	1

check-ups. The first registration for this study was performed at the age of 11–12 years. The mean age at the last registration was 20 years 6 months (SD 3.62, range 13.6–31.8 years).

The 41 children exhibited agenesis of 59 second lower premolars. The number of primary molars that could be monitored at the different registrations can be seen in Table 1.

The intra-oral radiographs were examined by one author (KB). The examination consisted of a subjective judgement of the amount of root resorption. There were six possible levels of

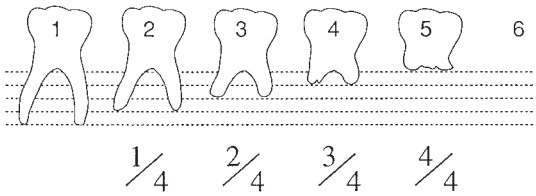

Figure 3 The different resorption stages used, measuring quarters of each root.

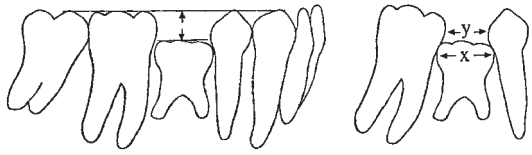

Figure 4 Illustration of how the infra-occlusion of the primary molar and the variable tipping of adjacent teeth were measured.

resorption (Figure 3). The mesial and distal roots were registered separately.

Infra-occlusion was, in this study, registered in tenths of a millimetre from the occlusal line to the occlusal surface of the primary molar (Figure 4).

Tipping of the adjacent teeth was expressed as the reduction of the distance 'y' between the permanent molar and the first premolar (Figure 4) and measured in tenths of a millimetre. The baseline for the distance was the width of the primary molar 'x'. The relationship between these variables was also analysed.

Statistical methods

All statistical analyses were performed using the SPSS software package (SPSS for Windows 95, version 8.0, SPSS Inc., Chicago, IL, USA). As the distributions were approximately normal, a Student's one-sample *t*-test was used to analyse whether resorption, infra-occlusion, and tipping of adjacent teeth, measured as a reduction of the distance between these adjacent teeth at baseline, was significantly greater than zero. A Student's paired *t*-test was used to analyse whether changes in the same variables between different registration stages were statistically significant. Relationships between resorption, infra-occlusion and tipping were analysed by Pearson's correlation coefficient (Kirkwood, 1996).

Errors of the method

The errors of measurements were estimated by duplicate determination with a 2-month interval of all measurements of 20 teeth. The errors were found to be small and with *t*-values below 1.96 except for two variables. These were 'tipping of adjacent teeth' and 'infra-occlusion', both at the third registration stage.

The differences between the two measurements were small. The mean distance between the adjacent teeth to the primary molar was, at the first measurement, 10.10 mm (SD 1.53) and, at the second measurement, 10.02 mm (SD 1.49). The mean distance for infra-occlusion was 1.45 mm (SD 2.03) at the first measurement and 1.55 mm (SD 2.12) at the second measurement.

The significant difference at $P < 0.05$ for these two variables was probably due to almost all different values at the second measurement for the variable 'tipping of adjacent teeth' (lower) and for the 'infra-occlusion' (higher) compared with the first measurement.

Results

General results

There were no significant differences for the variables used when comparing the two groups. Group A included one tooth randomly selected from each of the 41 cases (41 teeth) and Group B all 59 teeth from the 41 cases. The measurements and statistical analyses were therefore made on all 59 teeth. Of the 59 lower primary molars, only two were exfoliated during the observation period. Two children lost one tooth each due to exfoliation, one at the age of 13 years 6 months (possibly due to an atypical eruptive path of the adjacent first premolar) and the other at the age of 17 years 6 months.

Of the 59 lower primary molars, five were extracted before the age of 20 years. In one subject both the lower second primary molars were extracted, and in another a lower second

primary molar, in both cases at the age of 18 years. Extraction of both lower second primary molars followed by transplantation of the maxillary third molars was performed in one subject, at 19 years of age.

All the teeth that could be registered after age 20 years remained in the oral cavity until the end of the survey period.

Root resorption of the primary molar roots

Table 2 shows the amount of root resorption of the mesial and distal roots of the 59 teeth.

At the first registration (age 11–12) only seven mesial roots showed no root resorption. This was 11.9 per cent of the 59 teeth. Root resorption level 2 (one-quarter of the root resorbed) was found in 37.3 per cent; 44.1 per cent had resorption level 3 and 6.7 per cent (four teeth) exhibited resorption level 4 (three-quarters of the root resorbed).

The corresponding figures for the distal roots were 10 roots (16.9 per cent) without resorption, 37.3 per cent level 2, 40.7 per cent level 3, and 5.1 per cent (three roots) for resorption level 4. There was a tendency for more resorption on the mesial roots.

At 19–20 years of age all roots exhibited some degree of resorption (Table 2). For the mesial roots, 4.8 per cent showed resorption level 2, and 34.1 per cent level 3, e.g. a resorption of half of the root or less, and for the distal roots more than 50 per cent showed this degree of resorption.

From the first to the third registrations (11–12 years to 15–16 years), 34.5 per cent of the mesial roots did not change resorption level. From the third to the fifth registrations (15–16 years—19–20 years), 47.6 per cent showed no change of resorption level (Table 3). The corresponding figures for the distal roots were 31.0 and 61.9 per cent, respectively.

Infra-occlusion

Infra-occlusion of the primary molars could be seen in 12 of the 59 teeth at the first registration at 11–12 years of age. The development of infra-occlusion is shown in Tables 4 and 5. The mean infra-occlusion at age 11–12 years was 0.47 mm (SD 1.13) with a range from 0.0 to 5.2 mm. The mean infra-occlusion increased to 0.92, 1.27, and 1.43 mm at the next three registrations (Table 4). At the fifth registration stage (age 19–20 years) the mean infra-occlusion had decreased because four of the most infra-occluded teeth had been extracted or exfoliated. From Table 4 it can be seen that at the fifth registration (19–20 years of age) 40 teeth could be monitored. Twenty-two of these showed infra-occlusion between 0.0 and

Table 2 Number of teeth, expressed as a percentage, showing resorption stages at the different registrations, for the mesial and distal roots.

Resorption level	Age (years)																	
	11–12		13–14		15–16		17–18		19–20		21–22		23–24		25–29		30+	
	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D
1	11.9	16.9	3.4	8.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	37.3	37.3	28.8	32.2	20.7	24.1	9.1	18.1	4.8	12.2	–	10.0	–	12.5	–	–	–	–
3	44.1	40.7	32.2	32.2	41.4	39.7	41.8	45.5	34.1	41.5	50.0	50.0	50.0	37.5	20.0	20.0	–	–
4	6.7	5.1	33.9	23.7	31.0	32.8	36.3	23.6	51.3	39.0	50.0	40.0	50.0	43.8	80.0	60.0	100.0	100.0
5	–	–	–	1.7	6.9	3.4	7.3	7.3	9.8	7.3	–	–	–	6.2	–	20.0	–	–
6	–	–	1.7	1.7	–	–	5.5	5.5	–	–	–	–	–	–	–	–	–	–

M, mesial; D, distal.

Table 3 Percentage of retained primary molars that showed no change in the resorption level, or which changed 1, 2, or 3 stages from the first to the third registration or from the third to the fifth registration.

Change in resorption level	Registration stages			
	11–12 to 15–16 years		15–16 to 19–20 years	
	M	D	M	D
No change	34.5	31.0	47.6	61.9
One stage	53.4	56.9	50.0	35.7
Two stages	10.3	10.3	2.4	2.4
Three stages	1.8	1.8	–	–
Four stages	–	–	–	–
Five stages	–	–	–	–
Six stages	–	–	–	–

M, mesial; D, distal.

Table 4 Infra-occlusion (mm) at the different registrations, showing the number of teeth that could be measured.

	Registration stage/age (years)								
	1 11–12	2 13–14	3 15–16	4 17–18	5 19–20	6 21–22	7 23–24	8 25–29	9 30+
Mean (mm)	0.47	0.92	1.27	1.43	1.30	1.29	1.01	1.24	1.30
SD	1.13	1.56	1.45	1.13	1.39	1.42	0.99	1.51	–
Range	0.0–5.2	0.0–6.9	0.0–6.7	0.0–6.1	0.0–4.5	0.0–4.2	0.0–3.8	0.0–3.7	–
Number	59	59	58	55	40	20	16	5	1

4.5 mm, but 18 primary molars (45 per cent) still had no infra-occlusion.

Comparison of the 58 teeth that could be monitored at both the first and the third registration stages showed that there were significant differences in infra-occlusion (Table 5). The same could be seen for the 40 teeth that could be registered at the first, the third and the fifth stage.

Table 5 The changes in infra-occlusion at the different registrations. There were significant differences between the first and the third registrations, between the first and the fifth registrations, and also between the third and the fifth registrations. The mean difference in infra-occlusion, however, did not exceed 1 mm.

Registration stages	1–3	1–5	3–5
Mean change in infra-occlusion (mm)	0.79	0.99	0.30
SD	0.99	1.13	0.50
P	***	***	***
Number	58	40	40

P < 0.001

Tipping of the adjacent teeth

The mean distance ‘y’ between the first premolar and the first molar was 10.35 mm (SD 0.76) at the first registration, compared with the width of

the second primary molar 'x', mean 10.53 mm (SD 0.51; Table 6).

At the fourth registration (17–18 years of age) the mean distance 'y' was 9.95 mm (SD 1.50). After extraction of two primary molars with very small gaps the mean distance increased to 10.30 mm (SD 0.63) at the fifth registration (Table 6).

The mean change in the distance 'y' at the first registration was –0.17 mm (SD 0.51) compared with the mean width of the primary molars. From the first to the second registration the mean change was –0.12 mm (SD 0.31; Table 7). The maximum change was –0.20 mm between two successive registrations (3 and 4) and there was significant change in the distances at the successive registrations up to registration 5.

It was found that for only eight teeth was the change in the distance between the first premolar and the first molar in excess of –2 mm. In three of these instances, the primary molars were extracted or exfoliated.

The amount of tipping of teeth adjacent to the second primary molars, expressed as a reduction of the distance between the first premolar and the first molar, was very small. Even so, the

Table 6 Tipping of the adjacent teeth was measured as the distance between the first premolar and the first molar 'y' in comparison with the width 'x' of the primary molar (Figure 4).

Primary molar width ('x')		Distance between the first premolar and the first molar ('y')						
		1* 11–12**	2* 13–14**	3* 15–16**	4* 17–18**	5* 19–20**	6* 21–22**	7* 23–24**
Mean (mm)	10.53	10.35	10.24	10.06	9.95	10.30	10.30	10.27
SD	0.51	0.76	0.88	1.10	1.50	0.63	0.67	0.54
Range	9.3–11.6	7.6–11.6	6.6–11.6	5.1–11.4	2.7–11.4	8.3–11.4	8.6–11.4	9.0–11.4
Number	59	59	59	58	55	40	20	16

This table shows the distribution of the mean values at the different registrations and also standard deviation, range, and number of measured distances.
*Registration stage; **age (years).

Table 7 The mean changes in measurement 'y' at successive registrations and also between other registrations. Up to the age of 19–20 years (registration 5) there were significant differences, but the figures were small.

	Registration stages						
	0–1	1–2	2–3	3–4	4–5	5–6	6–7
Mean change in 'y' (mm)	–0.17	–0.12	–0.18	–0.20	–0.07	–0.08	–0.06
SD	0.51	0.31	0.39	0.61	0.18	0.19	0.12
P	*	**	**	*	*	NS	NS

	Registration stages			
	0–1	0–3	0–5	3–5
Mean change in 'y' (mm)	–0.17	–0.47	–0.37	–0.13
SD	0.51	0.99	0.58	0.22
P	*	***	***	**

NS $P > 0.05$; *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

distances decreased significantly between the five first registration stages, the decrease being only a maximum of 0.20 mm (Table 6). The standard deviations were very small.

Correlation

It was found that there was significant correlation at $P < 0.01$ between infra-occlusion of the primary molar and tipping of adjacent teeth at the first four registrations (Table 8).

There was significant correlation between root resorption and infra-occlusion of the primary molar at the first four registrations, up to 18 years of age. The correlation was significant at $P < 0.05$ at the two first registrations and at $P < 0.01$ at the next two registrations (Table 9). There were also correlations between root resorption of the primary molar and tipping of adjacent teeth. The correlation was significant at $P < 0.05$ at the first registration, at $P < 0.01$ at the second registration, and at $P < 0.001$ at the next two registrations (Table 9).

Discussion

Root resorption

At the first registration the degree of resorption was almost equal for the two roots, but 8–9 years later, more than 60 per cent of the mesial roots showed a resorption of half of the roots or more, while for the distal roots only 46 per cent of the roots were resorbed to this extent. No explanation could be found for this difference. For the teeth which could be followed after 20 years of age the

Table 8 The correlation between infra-occlusion of the primary molar and tipping of the adjacent teeth was significant at $P < 0.001$ for the first four registrations, and non-significant for the rest.

	Registration stage/age (years)							
	1 11–12	2 13–14	3 15–16	4 17–18	5 19–20	6 21–22	7 23–24	8 25–29
P	***	***	***	***	NS	NS	NS	NS
r	–0.59	–0.56	–0.63	–0.64	–0.30	–0.22	–0.31	–0.41

Table 9 The correlation between root resorption of the primary molar and infra-occlusion was at $P < 0.05$ for the first two registration stages, and at $P < 0.01$ for the next two registrations. The correlation between root resorption of the primary molar and tipping of adjacent teeth was at $P < 0.05$ at the first registration, and at $P < 0.01$ for the next registration. It was at $P < 0.001$ for the next two registrations, and non-significant for the rest of the registrations.

	Registration stage/age (years)							
	1 11–12	2 13–14	3 15–16	4 17–18	5 19–20	6 21–22	7 23–24	8 25–29
Infra-occlusion								
P	*	*	**	**	NS	NS	NS	NS
r	0.28	0.27	0.36	0.36	0.15	–0.18	–0.16	–
Tipping of adjacent teeth								
P	*	**	***	***	NS	NS	NS	NS
r	–0.21	–0.38	–0.50	–0.65	–0.15	0.25	0.44	0.15

root resorption remained at level 3 or 4 for the mesial roots but for some distal roots reached level 5 (Table 2), but no teeth were lost. Rune and Sarnäs (1984) in their investigation found that approximately 50 per cent of the deciduous second molars remained at the same root resorption stage during the entire observation period, while the other 50 per cent showed more than one resorption stage. The rate of root resorption varied widely between individuals. The mean age at the last registration in their study was approximately 17 years of age. The comparable figure in this investigation is the difference in resorption levels between the first and the third registrations (1–3) in Table 3. It can be seen that about 30 per cent remained at the same resorption stage.

It was found that four of the seven teeth that had been extracted or exfoliated were in patients 17–18 years of age. This is an appropriate age for transplantation of maxillary third molars with good prognosis (Lundberg and Isaksson, 1996). In one subject, a maxillary third molar was transplanted to the mandibular left second molar region at the age of 19, and followed for 5 years (Figure 2). All teeth that had exfoliated or had been extracted exhibited root resorptions of one-quarter or half of the roots at the first registration (11–12 years of age). However, most of the teeth that could be followed for 10 years or more also showed resorption of one-quarter of the roots or more at the first registration. The five teeth followed to more than 25 years of age all had root resorption between one-quarter and three-quarters of the roots at the first registration, but none of them went on to exfoliation or extraction (Figure 5).

It seems it is not possible to predict the probability of survival of the primary molars at an early age, when a decision concerning extraction should be made. However, from this study it can be concluded that the development of root resorption is very slow, and the prognosis for the primary molars after 20 years of age is good.

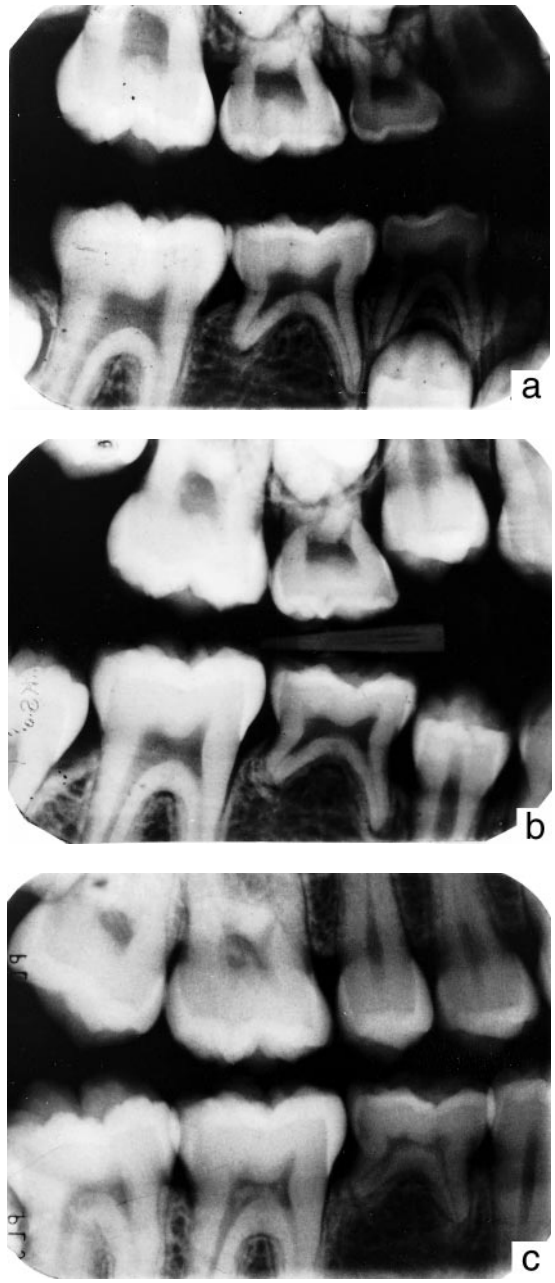

Figure 5 A lower right second primary molar at (a) 10 years, (b) 12.5 years, and (c) 28 years.

Infra-occlusion

All infra-occluded primary molars may be considered as ankylosed teeth (Dixon, 1962; Rygh and Reitan, 1964; Rune, 1971). The aetiology of ankylosis is unknown.

Despite very small figures for infra-occlusion the differences between the mean values at some

registrations were significant (Table 5), due to small standard deviations.

Somewhat less than 50 per cent of the teeth that showed infra-occlusion at age 19–20 years also exhibited some degree of infra-occlusion at the first registration. There is no typical pattern for the development of infra-occlusion. For instance, in one subject the infra-occlusion was 1.3 mm both at the first registration (11–12 years of age) and at the last registration 15 years later, while another subject developed infra-occlusion from 0 to 3.7 mm during the same period.

The patients who showed the greatest infra-occlusion at the first registration exhibited an increase of less than 2 mm during a 10-, 6-, and 7-year period, respectively. In two subjects the primary molars were extracted at the age of 18 due to root resorption.

No primary molar with severe infra-occlusion was found in this study. The mean increase in infra-occlusion from the first registration (10–11 years of age) to that at 19–20 years of age was 0.99 mm. Kurol (1981) defined infra-occlusion as when the occlusal surface of the primary molar is more than 1 mm below the occlusal plane.

After the age of 20 years, only one tooth increased infra-occlusion by more than 1 mm. It can therefore be concluded that infra-occlusion is not a problem for survival of the deciduous molars.

Tipping of the adjacent teeth

It has been shown that tipping of the first permanent molars and also sometimes the first premolar will appear when the second primary molar is lost early or is in infra-occlusion (Lindqvist, 1980; Mamopoulou *et al*., 1996).

In this study tipping of the teeth adjacent to a second primary molar expressed as a reduction of the distance 'y' (Figure 4) between the first premolar and the first molar, was very small (Table 7). Even so, the distances decreased significantly between the first five registration stages. The decrease was a maximum of 0.20 mm (Table 7). However, the strongest correlation was found between infra-occlusion of the primary molar and tipping of adjacent teeth, which was significant at $P < 0.001$ at all the first four registrations (Table 8).

It is clear that small reductions in the space available for the primary molars and small changes in infra-occlusion are clinically unimportant for most patients, but may be so if a third molar is to be subsequently transplanted to the area.

There were only eight primary molars with a reduction of the distance 'y' between the adjacent teeth exceeding 2 mm. Four of these were extracted or exfoliated.

Conclusions

Forty-one patients with agenesis of one or both second lower premolars were followed with intra-oral radiographs up to a mean of 20 years and 6 months (range 13.6–31.8 years). Only seven primary molars were lost during the observation period. The subjects were a selected group of children who had been diagnosed with agenesis of lower second premolars and where, for different reasons, the primary molars remained. The children who met these requirements all came from three districts in Sweden and the first registration was performed at the age 11–12 years. The material was thus not randomly selected among children with agenesis of second lower premolars and most primary molars exhibited some resorption of the roots at the first registration. Several of them even showed resorption of half of the root or more at the first registration. Despite this, the primary molars are still remaining at the 19–20 years registration or later.

Twenty per cent of primary molars showed infra-occlusion of 1 mm or more at the first registration, which is higher than that found in an earlier study.

Even though there was a strong correlation between infra-occlusion and tipping of adjacent teeth, infra-occlusion of the primary molar or tipping of adjacent teeth was not a problem clinically. Neither infra-occlusion, tipping of adjacent teeth, or root resorption increased very much after the age of 20.

If the primary molars remain in the dental arch at 20 years of age they have a good prognosis for long-term survival.

Address for correspondence

Dr Krister Bjerklin
Department of Orthodontics
Institute for Postgraduate
Dental Education
Klubbhusgatan 15
SE-553 03 Jönköping
Sweden

References

Bergström K, 1977 An orthopantomographic study of hypodontia, supernumeraries and other anomalies in school children between the ages of 8–9 years. Swedish Dental Journal 1: 145–157

Dixon D A 1962 Observations on submerging deciduous molars. Transactions of the British Society for the Study of Orthodontics, pp. 101–114

Grahnén H 1956 Hypodontia in the permanent dentition. A clinical and genetical investigation. Odontologisk Revy 7: Suppl. 3

Joondeph D R, McNeill R W 1971 Congenitally absent second premolars: an interceptive approach. American Journal of Orthodontics 59: 50–66

Kirkwood B R 1996 Essentials of medical statistics. Blackwell Science, London

Kurol J 1981 Infra-occlusion of primary molars: an epidemiologic and familial study. Community Dentistry and Oral Epidemiology 9: 94–102

Kurol J, Thilander B 1984 Infra-occlusion of primary molars and the effect on occlusal development, a longitudinal study. European Journal of Orthodontics 6: 277–293

Lindqvist B 1980 Extraction of the deciduous second molar in hypodontia. European Journal of Orthodontics 2: 173–181

Locht S 1980 Panoramic radiographic examination of 704 Danish children aged 9–10 years. Community Dentistry and Oral Epidemiology 8: 375–378

Lundberg T, Isaksson S 1996 A clinical follow-up study of 278 autotransplanted teeth. British Journal of Oral and Maxillofacial Surgery 34: 181–185

Mamopoulou A M, Hägg U, Schröder U, Hansen K 1996 Agenesis of mandibular second premolars. Spontaneous space closure after extraction therapy: a 4-year follow up. European Journal of Orthodontics 18: 589–600

Ödman J, Gröndahl K, Lekholm U, Thilander B 1991 The effect of osseointegrated implants on the dentoalveolar development. A clinical and radiographic study in growing pigs. European Journal of Orthodontics 13: 279–286

Ravn J J, Nielsen L A 1973 En ortopantomografisk undersökelse af overtal of aplasier hos 1530 Kobenhavnske skoleborn. Tandlægebladet 77: 12–22 (with English summary)

Rune B 1971 Submerged deciduous molars. Odontologisk Revy 22: 257–273

Rune B, Sarnäs K-V 1984 Root resorption and submergence in retained deciduous second molars. European Journal of Orthodontics 6: 123–131

Rygh P, Reitan K 1964 Changes in the supporting tissues of submerged deciduous molars with and without permanent successors. Odontologisk Tidskrift 72: 345–362

Steffensen B 1981 En longitudinal radiologisk-klinisk undersogelse af overtal og aplasi hos 415 jyske skoleborn (English summary). Tandlægebladet 85: 245–249

Thilander B, Myrberg N 1973 The prevalence of malocclusion in Swedish school children. Scandinavian Journal of Dental Research 81: 12–20

Wisth P J, Thunold K, Bøe O E 1974 The craniofacial morphology of individuals with hypodontia. Acta Odontologica Scandinavica 32: 293–302

Zuccati G 1993 Therapy in cases of agenesis. Journal of Clinical Orthodontics 27: 369–373