



ORIGINAL ARTICLE

Long-term space changes after premature loss of a primary maxillary first molar



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KEYWORDS

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Abstract *Background/purpose:* The consequence of premature loss of primary teeth resulting in the need for space maintainers has been controversial for many years. There is no longitudinal long-term report in literature regarding the premature loss of a primary maxillary first molar. The aim of this study was to continue observing the long-term space changes of 19 cases following premature loss of a primary maxillary first molar during the transition from primary to permanent dentition.

Materials and methods: Ten of the 19 original participants were excluded because of extensive decay or loss to follow-up. Nine children (mean age at time of tooth extraction, 6.0 ± 0.42 years) with unilateral premature loss of a primary maxillary first molar were examined. Maxillary dental study casts were obtained 2 days or 3 days after tooth removal and, on average, 81 months later. The contralateral intact primary molars in each participant served as controls. The arch width, arch length, intercanine width, intercanine length, and arch perimeter of each study cast from the initial and follow-up examinations were measured and compared using paired *t*-tests.

Results: Eight of nine cases (88.9%) did not show crowded permanent successors or canine block-out at the extraction site. Interestingly, the permanent dentition was more crowded at the control site (2/9) than at the extraction site (1/9). The arch width, arch length, intercanine width, and intercanine length significantly increased at 81 months ($P < 0.05$), whereas the arch perimeter increases approached significance ($P = 0.071$).

Conclusion: The anterior and posterior arch dimensions significantly increased 81 months after premature loss of a primary maxillary first molar, which suggested that space maintainers were not needed in these cases.

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Introduction

Clinical studies of space changes that result from the premature loss of primary molars have a wide range of findings, including the direction of space change, the amount of space loss, and the need for a space maintainer.^{1–11} These inconsistencies may have resulted because many early investigations had cross-sectional designs, small sample sizes, and somewhat crude methodologies.¹⁰ Tunison et al¹² systematically reviewed all of the studies on space changes following the premature loss of primary first molars that had been published prior to July 2007 and found that the methods of only three of 79 were of sufficient high quality to warrant consideration for the review. Recent studies regarding space change after premature loss of a primary molar improved their methodologies by conducting longitudinal studies, using contralateral primary molars as controls, and increasing the sample sizes.^{13–18} These studies concluded that the arch with the premature loss of deciduous molars did not exhibit any significant dimensional changes but the loss of second primary molars affected dental arch more than first primary molars did.¹⁸

The high quality of the methods of our serial studies of space changes following unilateral extraction of a primary first molar in either maxillary or mandibular arches during certain periods of arch development was recognized as a high methodological quality in Tunison et al's¹² review.^{12–15} In 1998, we conducted a study with a strict sampling regimen and collected longitudinal data on the space changes after premature loss of a primary mandibular first molar. We found that the early space change in the mandibular dental arch consisted primarily of distal movement of ~1–1.5 mm of the primary canine toward the extraction space within 8 months.¹³ In 2007, in a related study of the effects of the premature loss of a primary maxillary first molar, we found a similar distal drift of the primary canine, which was ~1 mm of space loss within 6 months of the extraction and which was likely not of sufficient clinical significance to warrant the use of a space maintainer.¹⁴ In 2011, in a study that extended the follow-up of the 2007 study to 12 months, the anterior segment (intercanine width and length) was increased. The mesial movement of permanent molars or the tilting of the primary molars did not occur, which suggested that space maintainers are not needed in cases involving the premature loss of a primary first molar.¹⁵

In order to better understand the ongoing space changes after 12 months and during the transition from primary dentition to permanent dentition, the present study extended our previous investigations of the 6- and 12-month space changes after premature loss of a primary maxillary first molar. The purpose of this study was to use established longitudinal data to investigate ongoing (81 months) dental-arch space problems that resulted from premature loss of a primary maxillary first molar.

Materials and methods

Nine children (seven boys and two girls) with unilateral premature loss of a primary maxillary first molar were selected for this study from the Children's Dental Clinic of

Kaohsiung Chang Gung Memorial Hospital. Ten of the 19 original participants were excluded because of extensive decay or loss to follow-up. All of the participants met the following inclusion criteria specified by the protocol described in our previous study,^{14,15} as follows: (1) no major craniofacial disease was apparent; (2) the permanent first molars were about to erupt or had just erupted; (3) the patient was cooperative in finishing dental treatment before impressions were obtained; (4) the maxillary dentition featured the unilateral premature loss of a primary first molar due to extensive caries but had intact contralateral primary molars; (5) premature loss of the primary molar was defined as the absence of a permanent tooth for at least 2 years after extraction of the primary molar; however, the permanent tooth eventually would erupt into the space; (6) parents or guardians did not want their child to receive dental treatment involving the use of a space maintainer; and (7) all parents of the children included in the study signed a consent form. Ethical approval for the study was granted by the Institutional Review Board of Chang Gung Memorial Hospital (Institutional Review Board number 100-2162D).

Maxillary dental study casts of the participants were obtained 2 days or 3 days after the tooth was removed and at a follow-up appointment that occurred, on average, 81 months later. None of the study participants were treated with any type of space maintainer during the entire follow-up period. We obtained longitudinal study casts in order to compare them with the initial study casts. The five reference lines used as test parameters were measured directly from the reference points on the dental casts, and two experienced researchers (Y.-T. L. and W.-H. L.) determined the lines using an electronic digital caliper, which was accurate within 0.01 mm.

Cast measurements

The researchers measured the following five reference lines of dental-arch development: arch width, arch length, intercanine width, intercanine length, and arch perimeter. We defined these parameters as follows:

- (1) the arch width is the distance between the central fossae on the occlusal surfaces of the two primary second molars (primary dentition) or two second premolars (permanent dentition; [Figures 1A and 2A](#));
- (2) the arch length is the perpendicular distance from the contact point of the central incisors to the arch width ([Figures 1A and 2A](#));
- (3) the intercanine width is the distance between the cusp tips of the two primary canines or two permanent canines ([Figures 1B and 2B](#));
- (4) the intercanine length is the perpendicular distance from the contact point of the central incisors to the intercanine width ([Figures 1B and 2B](#));
- (5) the arch perimeter, which is measured with the aid of brass wire, is the arc from the mesial midpoint of the permanent first molar (or the distal midpoint of the primary second molar) through the cusp tip of the canine and the incisal edges of the incisors to the opposite mesial midpoint of the permanent first

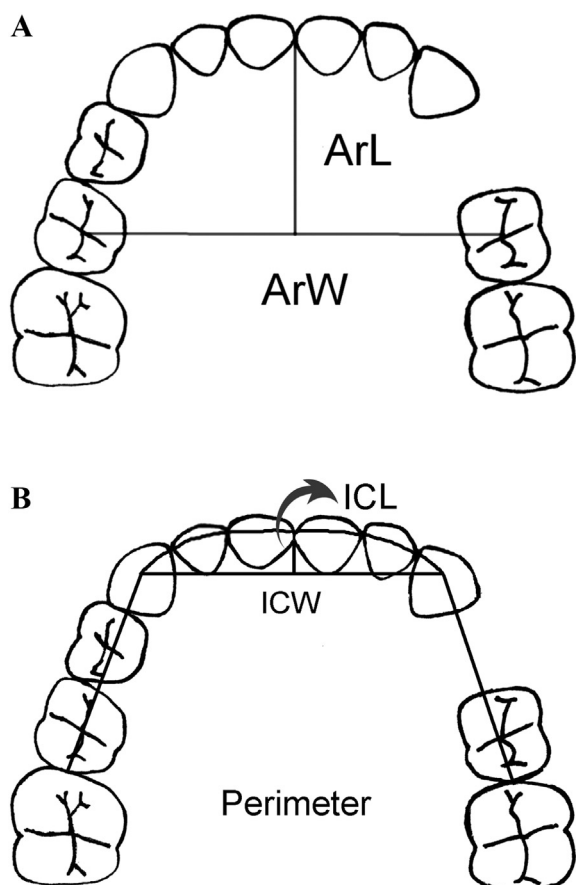


Figure 1 Measurements of the (A) arch width (ArW), arch length (ArL); (B) arch perimeter, intercanine width (ICW), and intercanine length (ICL) of the initial study cast.

molar (or the distal midpoint of the primary second molar; [Figures 1B and 2B](#)).

Statistical analysis

We used the Shapiro–Wilk test and statistical software (SPSS 11.0, IBM Corporation, Armonk, NY, USA) to test all of the data for normality and homogeneity. The results showed that all of the data were reasonably normally distributed for the use of parametric tests ($P > 0.05$). We used paired *t*-test to compare the cast measurements between the initial and 81-month follow-up examinations. The level of significance (α) was 0.05.

Interexaminer and intraexaminer reliability tests

We used reliability coefficients to determine the consistency and reliability of the measurements of each cast that were made with an electronic digital caliper between the intraexaminer and interexaminer groups. The two examiners (Y.-T. L. and W.-H. L.) followed the same protocol that used in the previous 6-month investigation and recorded the measurements for reliability testing within a maximum period of 3 weeks.¹⁴ The means and standard deviations of five measurements of each cast were the parameters used

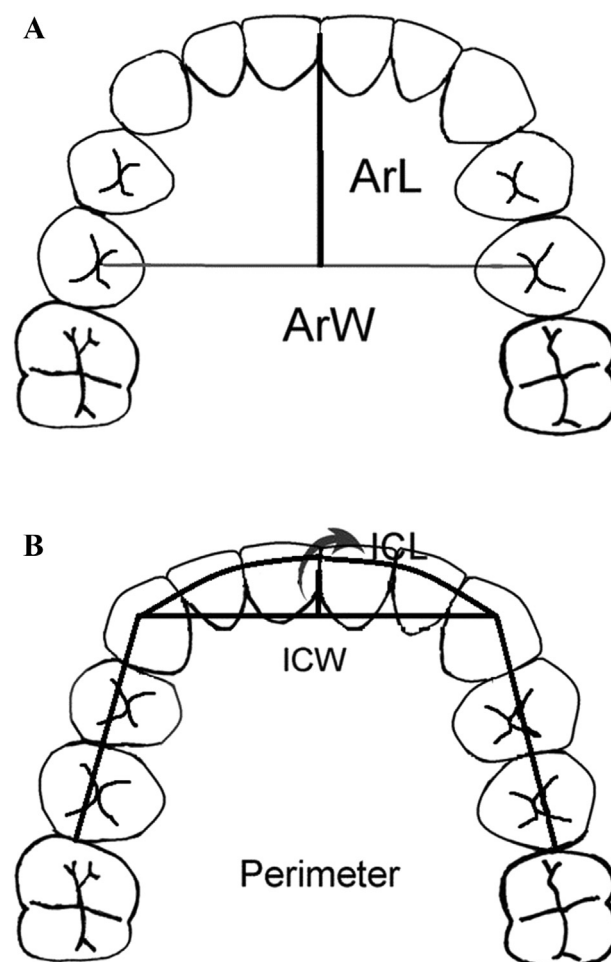


Figure 2 Measurements of the (A) arch width (ArW), arch length (ArL); (B) arch perimeter, intercanine width (ICW), and intercanine length (ICL) of the final study cast.

to compare the interexaminer and intraexaminer groups. The indexes of reliability greater than 0.900 for both the interexaminer and intraexaminer groups showed that the measurements had excellent consistency and reliability.¹⁴

Results

The ages of the nine participants at the time of extraction ranged from 5 years 1 month to 7 years 7 months, with a mean \pm standard deviation age of 6.0 ± 0.42 years. The dentition of all of the participants had transferred from primary or mixed dentition to permanent dentition during the 81-month follow-up period. Eight of the nine cases (88.9%) showed no crowded permanent successors or canine block-out at the extraction site at the 81-month follow-up examination. By contrast, more crowded permanent dentition was found at the control site (2/9) compared with the extraction site (1/9). A significantly greater arch width, arch length, intercanine width, and intercanine length were found after 81 months compared with the initial parameters ($P < 0.05$; [Table 1](#)). No significant difference was found in the arch perimeter. However, it approached statistical significance with $P = 0.071$ ([Table 1](#)).

Table 1 Changes in arch width, arch length, intercanine width, intercanine length, and arch perimeter between the initial examination and 81-month follow-up.

	Measurement (mean \pm SD; mm)		P
	Initial examination (n = 9)	81-month examination (n = 9)	
Arch width	40.14 \pm 1.14	42.39 \pm 3.30	0.023*
Arch length	20.38 \pm 2.31	23.09 \pm 1.53	0.007*
Arch perimeter	78.53 \pm 3.54	82.20 \pm 4.59	0.071
Intercanine width	30.83 \pm 1.99	35.43 \pm 3.08	0.010*
Intercanine length	6.36 \pm 1.40	8.10 \pm 0.97	0.002*

* Statistically significant at $\alpha < 0.05$.
SD = Standard deviation.

Discussion

Research on the long-term space changes of the dental arch is inevitably to face the collection and maintenance of qualified cases. In the present study, 10 out of the 19 original participants were excluded mostly because of extensive decay that would result in significant errors in the measurements. In longitudinal studies, the participants with unilateral loss of one primary molar, as in the present study, would face further extraction of adjacent teeth due to the high rate of caries, and this resulted in an exclusion of samples from the study.

The arch dimension, arch width, arch length, intercanine width, and intercanine length were significantly greater 81 months after the tooth extraction than the corresponding values at the initial examination. Although the difference in the arch perimeter did not reach statistical significance, a significant increase might have been found if more samples had been examined. The overall results of this study showed that the space was regained and increased during the transition from primary dentition to permanent dentition. These results might have been related to the eruption path of the incisors and the natural expansion of the primary canines during the eruption of the permanent laterals.¹⁹ The substantial increase in both the intercanine width and length indicated that the permanent incisors and canines erupted in a more labial position, which resulted in an increased total arch dimension.

The results of this long-term study challenges the use of space maintainers, including the band-and-loop and palatal arch types, to preserve the extraction space following premature loss of a primary maxillary first molar. The results of our previous 6-month investigation suggested that a space loss of only 1 mm was not likely to have enough clinical significance to warrant the use of a space maintainer. If the palatal movement of maxillary incisors needs to be prevented, the use of a palatal arch instead of a band-and-loop maintainer is recommended.¹⁴ The 12-month investigation found increases in the arch dimensions in the anterior segment (intercanine width and length) and no mesial movement of the permanent molars or the tilting of primary molars, which suggested that space maintainers are not needed in cases of premature loss of a

primary first molar.¹⁵ The results of the 81-month follow-up investigation further verified that space maintainers were not needed because the increases in the total arch dimensions, both in the anterior and posterior segments (arch width and length), provide enough space for the space loss that occurs following premature extraction.

In addition, this study found that most of the cases showed no crowding of the permanent successors or canine block-out at the extraction site, which was thought to have deficient space following a premature extraction (Figure 3). By contrast, two cases exhibited crowded permanent dentition at the control site, which was thought to have sufficient space, including leeway space (Figure 4). Thus, these results suggested that multiple factors affect the space changes in developing arches, but evidence for this is lacking. These factors may include age at the time of tooth loss, transition from deciduous to permanent dentition, facial and dental growth potential, status of dental interdigitation, and oral habits.^{10,12}

Regarding the timing of the premature extraction of primary molars before and after the eruption of the permanent first molar, Terlaje and Donly¹⁹ reviewed the treatment plans for space maintenance and suggested that no treatment was administered for unilateral loss of a primary first molar in patients in whom the permanent first molar had erupted unless the leeway space was to be preserved. The present results further confirmed that space maintainers were not needed in cases involving premature

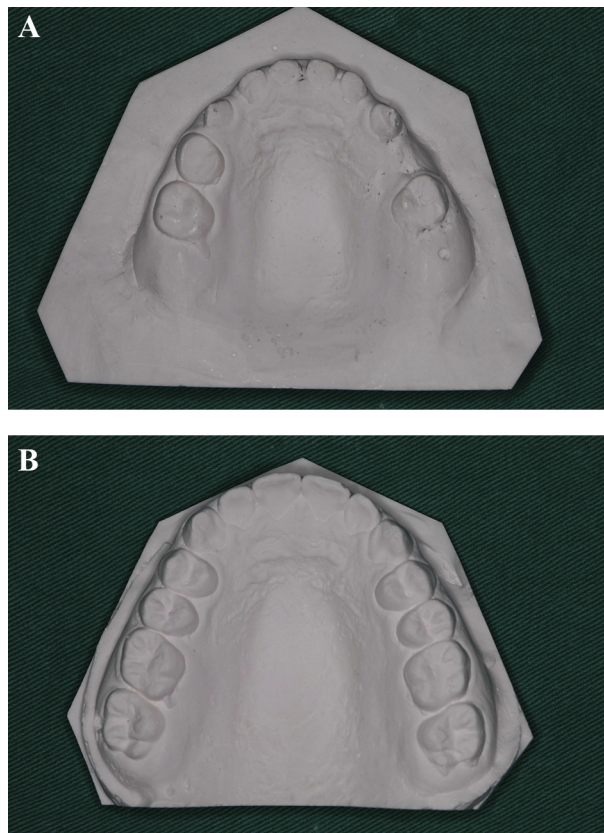


Figure 3 The case showed no crowded permanent successors or canine block-out at the extraction site after 81-month follow-up.

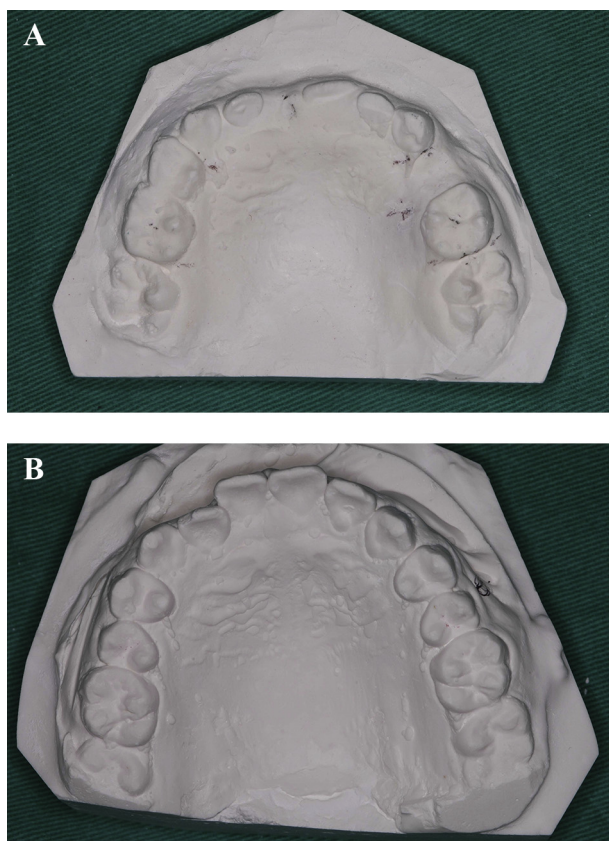


Figure 4 The case showed crowded permanent successors at the control site compared with the extraction site after 81-month follow-up.

loss of a primary maxillary first molar around the time that the permanent first molar was about to erupt or had just erupted.

The findings of our serial studies revealed only part of the scenario concerning the premature loss of primary molars. The clinical management of space loss after the early removal of a primary first molar can be managed with several evidence-based clinical solutions.^{13–15} We found that the mesial movement of permanent molars or the tilting of the primary molars after premature removal of a primary first molar did not occur in either the maxillary or mandibular arch during a certain period of time. An increase was found in the total arch dimensions, especially in the maxillary arch, during the transition of primary dentition to permanent dentition. Although there is not much controversy regarding the need of a space maintainer after the loss of a primary second molar, further longitudinal and well-controlled studies are needed to provide a more complete picture regarding the premature loss of primary molars.

The 81-month space changes in the maxillary dental arch following premature loss of a primary maxillary first molar showed a significant increase in the total arch, including both the anterior and posterior segments. These findings suggested that the use of space maintainers is not needed in cases involving the premature loss of a primary maxillary first molar around the time that the permanent first molar is about to erupt or has erupted.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

Acknowledgments

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