



ORIGINAL ARTICLE

# Clinical evaluation of short term space variation following premature loss of primary second molar, at early permanent dentition stage



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**Abstract Purpose:** The present study aimed at determining whether the premature loss of a deciduous second molar results in a clinically relevant loss of space and arch length reduction.

**Methods:** Split mouth evaluation of approximately 32 patients at early permanent dentition stage with unilateral premature loss of the deciduous second molar either in the upper arch or the lower arch. The contra lateral side with no tooth loss served as controls. Dental models and radiographs were obtained. The space in the extraction site and control sides were measured and analyzed for space loss and eruption stage of premolars in three weeks time frame.

**Results and conclusion:** The mean combined space before second primary molar extraction was 25.04 mm ( $\pm 4.25$ ), while the average space post extraction was 24.61 ( $\pm 4.27$ ) and the difference was found to be statistically significant ( $P < 0.01$ ). Furthermore, neither subject's age, nor successor premolar eruption stage were found to be correlated significantly with the amount of space loss ( $P$ -values 0.989 and 0.811, respectively). Space loss after premature extraction of second primary molar in three weeks time frame was statistically significant thereby emphasizing the use of space maintainers at the earliest.

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## 1. Introduction

Childhood dental caries and its effects on quality of life among the current younger generation is considered a major public health issue in many parts of the modern world (Petersen, 2003). The consequential need for extraction of the primary teeth often leads to arch space loss and eventual malocclusion in the permanent dentition (Northway, 2000). Further, the eruption pattern of the permanent dentition is controlled by various morphologic, genetic and environmental factors and any deviation in these factors may influence the occlusion

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(Baume, 1950). Among these factors is the primary dentition, which has a role in determining the amount of space required for normal eruption of permanent successors (Baume, 1950). The physiological exfoliation of primary teeth favors a normal alveolar growth and allows for a better accommodation of the successor permanent teeth (Baume, 1950). On the contrary, the premature loss of primary teeth would result in arch space loss (Davenport, 1887). Earlier studies investigating the early loss of primary first molar have controversial opinions about space closure. However, clinically significant effect on developing dentition is evident when there is premature loss of second primary molar (Macena et al., 2011). Some of the reported effects include tipping of the first permanent molar, crowding of the dental arch, malposition of adjacent teeth, impaction of the associated permanent tooth, increased overbite, arch asymmetries, occlusal impairment and disrupted eruption pattern (Owen, 1971; Murshid et al., 2016).

The dimension and spacing of the dental arches play a vital role in space closure after premature loss of the deciduous teeth. Especially, in clinical scenarios with smaller jaw dimensions and deficient space, early loss of primary first or second molar causes space closure resulting in crowding of the permanent dentition (Padma Kumari and Retnakumari, 2006). During the healing phase, distal movement of primary mandibular canine is often evidenced (Kisling and Hoffding, 1979) whereas in the maxilla, the primary second molar predominantly drifts mesially into the extraction site (Greatrex et al., 2002). Further, reported mesial migration of the first permanent molar during the mixed dentition raised greater concern (Kupietzky, 2007; Ronnerman, 1977; Love and Adams, 1971). The extraction of primary second molar before or during the eruption of first permanent molar possibly will result in severe space loss (Goerig and Camp, 1983).

The second deciduous molar is most often prone to destruction and early loss. Premature loss of primary second molar is attributed to multiple etiological factors like caries, trauma, ectopic eruption, congenital disorders (Lin et al., 2011). Space maintenance is advocated in such situations for prevention of reduction in arch length, width or perimeter by preserving the positions of the existing dentition (Lin and Chang, 1998). However, more studies support the mandatory use of space maintainer only in cases of early loss of primary second molar in par with primary first molar due to the increased potential of mesial migration or tipping of the first permanent molar (Tunison et al., 2008).

The first known study that attempted to quantify space loss was performed by Liu WA, who reported that the early loss of a maxillary primary second molar would result in a space loss of 2.49 mm. The loss of a maxillary primary first molar would result in a space loss of 2.2 mm, while the loss of both maxillary primary first and second molars would result in a space loss of 2.3 mm. In the mandibular arch, the corresponding space loss of due to extraction of a primary second molar, primary first molar or both would be 1.38 mm, 1.42 mm and 1.93 mm, respectively (Liu, 1949).

In 2007, Proffit advocated the extraction of second primary molar which has no successor in a child of age 7–9 facilitating the first molar to drift mesially. However, this can produce partial or even complete space closure. Unfortunately, the amount and direction of mesial drift varies and hence mandates future comprehensive dental treatment (Proffit et al., 2007). Nevertheless, it would be beneficial in determining the

treatment plan, if the pediatric dentist could predict the consequences of premature loss of primary teeth in the short and long term. As the long term effect is well established in the literature, the present study aimed at determining whether the premature loss of a deciduous second molar (after the eruption of permanent first molar) results in a clinically significant space loss within three weeks, which would stress the importance of faster methods of space maintainers delivery.

## 2. Material and methods

### 2.1. Study participants

The sample size calculation with a power of 90% and a 0.05 level of significance, enumerated that a total of 32 subjects at early permanent dentition stage were required to validate a difference in space loss up to 0.36 mm. The present study was approved by the clinical ethical committee at the College of Dentistry Research Center (CDRC No. 3201), Deanship of Scientific Research, King Saud University. An informed consent was obtained from all subjects and their parents. The participants were enrolled from the outpatient clinic, Department of Pediatric Dentistry, College of Dentistry, King Saud University, Riyadh. All the subjects who fulfilled the below criteria were included in the study:

- a) Upper or lower second primary molar indicated for extraction.
- b) Presence of first permanent molar at the side of extraction (adjacent and opposing to the extraction site).
- c) No recent extraction of first primary molar on the side of investigation in the past 6 months.
- d) Absence of severe displacement of the tooth at the extraction site (the posterior segment).

A total of 32 (17 males; mean age  $8.9 \pm 1.4$  and 15 females; mean age  $9.1 \pm 1.6$ ) subjects with a unilateral premature loss of the second deciduous molar who fulfilled the inclusion criteria were included in the study. Among the 32 study participants with unilateral premature loss of second molar, 12 subjects presented it in the upper dental arch while 20 patients in the lower arch.

Dental models and radiographs were obtained during pre-clinical examination and were analyzed. An alginate impression for the dental arch under assessment was taken immediately before the indicated extraction. The second impression was taken 3 weeks post extraction just before the cementation of the indicated space maintainer appliance. As part of the study protocol, the 3 weeks duration coincided with the time required for the laboratory construction of the appliance.

### 2.2. Evaluation of dental model

The dental models were analyzed to record

- a) Angle's molar relation on both sides
- b) Extraction space was evaluated on the dental models both before and after the procedure using a modified digital caliper. The extraction space was measured from the intercuspal fissure of first permanent molar to the

incisal tip of primary canine. In case of the missing canine, the space was measured from buccal groove of the first permanent molar to the distal inclination of the lateral incisor. The contra lateral side with no tooth loss served as controls.

### 2.3. Radiographic evaluation

Developmental stage of the premolar was determined by bitewing radiograph from the patient's file as part of the essential treatment planning records. In case where no recent radiographs were available (3 months), a new radiograph was requested for the purpose of updating patient's record. Stages of premolar development was recorded in relation to the occlusal plane of the adjacent first permanent molar. This was effectively recorded based on the position of second premolar judged in reference to cement-enamel junction (CEJ). When the tip of premolar cusp was located above the reference point, it was labeled as *advanced stage* wherein the space maintainer is not mandatory. If the tip of premolar was below the CEJ of the adjacent first permanent molar, it was labeled as *early stage* with a definite indication for a space maintainer.

### 2.4. Statistical analysis

The data obtained were analyzed using Statistical Package for the Social Sciences (SPSS) version 21.0 software (SPSS Inc., Chicago, IL, USA). The mean values were calculated for the demographic variables, paired *t*-test was used to investigate for any statistical significant differences between the difference of means of the paired sample (i.e. space condition before and after extraction for each subject). Student *t*-test and ANOVA were used to test for any statistically significant differences among the subgroups of the studies by the confounding factors.

## 3. Results

Examiner bias was obviated by single investigator measurements of the study models. Intra-class correlation coefficient (ICC) was used to test the intra-examiner reliability. Variables on study models were collected twice on 15 randomly selected study models with one-week interval between each of the two measurements session. The resulted ICC value (1.00) reflected high intra-examiner reliability.

Mean space loss was found to be statistically insignificant among gender and arch-types (P-values 0.241 and 0.675, respectively). In addition, analysis with ANOVA test did not reveal any statistical significance of the mean space loss between groups with differing molar relationship (P = 0.234). However, the mean space loss associated with Class II molar relationship (0.521 mm  $\pm$  0.267) was higher than the one found in Class I molar relationship (0.386 mm  $\pm$  0.243) (Table 1).

The calculated mean of mesiodistal space before the extraction of second primary molar was 25.04 mm ( $\pm$  4.25). While the average of the post extraction space measured 24.61 ( $\pm$  4.27). The mean difference of space loss was calculated and was found to be 0.426 mm ( $\pm$  0.252). Interestingly, the difference between pre and post extraction space was found to be statistically significant (P < 0.01) (Table 2). Nevertheless, neither subject's age, nor the successor eruption stage were found to correlate significantly with the amount of space loss (P-values 0.989 and 0.811, respectively) (Table 3).

## 4. Discussion

Premature loss of primary second molar results in definite reduction of extraction space. Early detection, can provide a clinical guide based on their heterogeneity for treatment planning during mixed dentition and prevent severe malocclusion. Owing to the multifactorial determinants, nature of problem in each patient when prioritized will reduce the risk of bias assessment and effective comprehensive planning. The present study evaluated the space changes following premature loss of primary second molars and also assessed the need for space maintainers following premature loss of second deciduous molars. Since, the early loss of the primary teeth results in space loss there is subsequent tipping of the first permanent molar, impaction or delayed eruption of the permanent teeth and

**Table 2** Comparisons of the space changes of primary second molar on extraction and control side.

Measurement side	Space changes (in mm)		'P' value
	Pre extraction	Post extraction	
Extraction side	25.04 $\pm$ 4.25	24.61 $\pm$ 4.27	0.021*
Control side	25.19 $\pm$ 0.59	25.20 $\pm$ 0.61	0.324

\* Indicates significant differences (p < 0.05).

**Table 1** Comparison of space measurements among different variables.

Variables	Participants	Pre extraction	Post extraction	Mean space loss	'P' value*
Sex	Male (17)	24.84 $\pm$ 0.34	24.41 $\pm$ 0.45	0.43 $\pm$ 0.22	0.241
	Female (15)	25.26 $\pm$ 0.29	24.93 $\pm$ 0.52	0.33 $\pm$ 0.65	
Arch	Upper (16)	24.65 $\pm$ 1.21	24.25 $\pm$ 0.59	0.45 $\pm$ 0.45	0.675
	Lower (16)	25.36 $\pm$ 0.98	24.87 $\pm$ 0.39	0.49 $\pm$ 0.33	
Molar relationship	Class I (24)	25.44 $\pm$ 0.87	25.05 $\pm$ 0.76	0.39 $\pm$ 0.24	0.234
	Class II (7)	24.58 $\pm$ 0.65	24.06 $\pm$ 0.39	0.52 $\pm$ 0.26	
	Class III (1)	18.50 $\pm$ 0.63	17.96 $\pm$ 0.43	0.54 $\pm$ 1.29	

\* Indicates insignificant differences (p < 0.05).

**Table 3** Analysis of Pearson's correlation coefficient of space loss with premolar eruption stages and age.

Control	Variables		Premolar eruption stage	Age
Space loss	Premolar eruption stage	Correlation	1.000	0.020
		Significance (2-tailed)	.	0.811*
		df	0	26
	Age	Correlation	0.069	1.000
		Significance (2-tailed)	0.989*	.
		df	26	0

\* Correlations is insignificant at 0.01 level.

crowding of the permanent dentition (Alnahwi et al., 2015; Davenport, 1887). Nevertheless, the premature loss of primary second molar before or during the eruption of first permanent molar is reported to result in severe space loss (Alnahwi et al., 2015). However, all our study subjects had the presence of fully erupted first permanent molar as one of the inclusion criteria.

In 2011, Macena and her colleagues studied the space changes after premature extraction of primary second molars with a 3 month follow up period. According to their research, major effect on the dental arches occurred in the first 3 months after the extraction with a reported the space loss of  $1.2 \pm 0.8$  in the maxilla and  $0.8 \pm 0.7$  in the mandible (Macena et al., 2011). However, there was lack of clinical evidences before the 3 month period. Interestingly, in the present study, within 3 weeks time frame, the mean space loss was found to be  $0.426 \pm 0.252$ . This demonstrates that more than 40% of the space loss recorded in 3 months occurs within the first 3 weeks.

In addition, Tatjana et al. (2008) assessed the effect of early loss of primary lateral teeth on supporting zone; including primary canine, first and second primary molars in 100 subjects (8–10 years). A definite reduction of the mesio-distal diameter was observed in patients with damaged supporting zone except in cases with innately longer dental arch such as mandibular prognathism. However, cases with Class II division 1 malocclusion or patients with primary spacing also had greater reduction in space after early loss. On the contrary, in primarily crowded arches, the loss of space was rapid and intercuspatation was found to decelerate sagittal migration of lateral teeth. Nonetheless, in the current study, angle's classification had no statistical significant influence on the space loss, although the mean space loss associated with Class II molar relationship was higher when compared with Class I molar relationship. This later finding was in agreement with a previously reported study (Tatjana et al., 2008).

Breakspear reported in a cross-sectional study that the space loss of the second primary molar results in an arch length reduction of 2.2 mm in the maxilla and 1.7 mm in the mandible (Breakspear, 1959). Interestingly, the present study also showed an increased space loss in maxillary arch as compared to mandibular arch which was in agreement with the previous studies (Pokorná et al., 2016; Liu, 1949). Furthermore, Breakspear (1959) also attempted to quantify the space loss due to premature loss of second primary molar. Using the unaffected side as a control, in a cross-sectional study he examined schoolchildren and reported the notable difference in the affected side. The research findings gave a detailed enumeration on the space loss after extraction of primary first and second molars in the maxillary or mandibular arches. Premature loss of primary first molar in maxilla and mandible resulted in

arch length reduction of 0.8 mm and 0.7 mm, respectively. Whereas, in case of second primary molar, the space loss was 2.2 mm in the maxilla and 1.7 mm in the mandible. Also, if both the primary molars were lost early, the arch length reduction was 2.0 mm in the maxilla and 1.3 mm in the mandible (Breakspear, 1959).

An increased amount of space loss in the maxillary arch may be due to significant mesial rotation of the first molars around the palatal root and reduced lee way space as compared to mandibular arch (Pokorná et al., 2016). Recommendations for space maintainers needs the direct evaluation of the relation between the measured space loss and the lee way space. The lee way space could be around 1.8 mm in the maxilla and 2.4 mm in the mandible. In this regard, the loss of space in maxillary arch needs utmost consideration for providing a space maintainer.

The premature loss of the second primary molar causes a greater reduction in the lee-way space than the premature extraction of the first primary molar and has a more important effect on malocclusions in permanent dentition (Petcu et al., 2016). Unfortunately, there was scarcity of scientific evidences correlating the eruption stage of permanent second premolar and space loss after premature loss of primary second molar. However, in the present study the eruption stage of permanent second premolar correlates insignificantly with the measured space loss.

Given the nature and limitation of current study, future studies have to comprehensively evaluate the spatial relationship affected by the premature loss of the second primary molar with stable reference points against advocacy of mandatory space maintainers and the consequential reduction in complex treatment needs.

## 5. Conclusions

Based on our study results we were able to conclude that space change after premature loss of second primary molar and the eruption of the first permanent molar in three weeks was statistically significant thereby emphasizing the use of space maintainers at the earliest. However, emphasize on the use of space maintainers at the earliest is recommended especially in cases of incisor and /or lip protrusion or patients with severe arch length deficiencies.

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**Conflict of interest**

The authors have no conflict of interest to declare.

**Ethical statement**

The present study was approved by the Clinical Ethical Committee at the College of Dentistry Research Center (CDRC No. 3201), Deanship of Scientific Research, King Saud University. An informed consent was obtained from all subjects and their parents.

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