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"Space loss following premature extraction of primary molars"

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1. Introduction:

Maintenance of primary teeth is essential for establishing normal permanent occlusion. premature loss of primary teeth, which has been defined as the loss of a dental organ before the time of natural exfoliation [1], is most commonly caused by dental caries. Other causes may include trauma, ectopic eruption, congenital disorders, and arch length deficiencies causing resorption of primary teeth [2].

In developing countries such as Iraq, where high availability of fermentable carbohydrates and lack of awareness regarding good oral hygiene have resulted in keeping dental caries as the main causative factor for the high rate of premature extraction of primary teeth [3].

The effect of premature loss of primary teeth is divergent and controversial as which tooth was lost [4] in which arch [2] and at what time and with what underlying malocclusion and whether the first permanent molar has erupted or not [5]. In general, the potential outcome for such loss has found to increase the need for Orthodontic treatment by 18% [6]

When the primary first molar is prematurely lost, space loss may or may not take place [7]. If it happens, it usually results from distal migration of primary canine [8], which usually occurs within the first 4 to 6 months following extraction [9]. Whereas premature loss of primary second molar will mostly cause space loss by mesial tilting of first permanent molar [4 & 10]. Several studies show that space loss is greater in the mandible than the maxilla and when occur at earlier age in crowded as opposed to spaced dentition [2].

When space loss following premature extraction of primary molar is expected, the American Academy of Pediatric Dentistry have recommended to use space maintainers in order to prevent the loss of arch length, arch width, and/or arch perimeter by maintaining the relative position of the existing dentition [11]. However, The Royal College of Surgeons of England have suggested that space maintainers would be most valuable in two situations: i) Loss of a primary molar where crowding is severe; ii) Loss of a second primary molar except in spaced arches [12]. Despite that, there is a lack of consensus regarding the effectiveness of space maintainers in preventing or reducing the severity of malocclusion [11]. This lack of consensus on the need of space maintenance in such cases poses the need for generation of evidence-based information to support treatment decisions [13].

Previous studies conducting to assess space change effects of premature loss of primary molars had small sample sizes, and somewhat crude methodologies. Whereas more recent studies improved their methodologies by conducting longitudinal studies, using contralateral primary molars as controls, and increasing the sample sizes [10].

Since the premature loss of primary molars is still a very common condition within Iraqi children and because few studies have conducted in Iraq to investigate space loss following premature loss of primary molars, the aim of this study was to assess the prevalence and amount of space loss following premature extraction of primary molars in the mixed dentition stage for a group of Iraqi schoolchildren.

2. Methods:

2.1. Design, population, and study sample

This observational retrospective cross-sectional comparative study was performed by the fifth stage undergraduate dental students under the supervision of specialists in Pediatric and Preventive Dentistry.

Initially, 186 randomly selected children were examined. These children were outpatients attending the department of Pediatric and preventive dentistry at the University of Babylon, College of Dentistry for the period from November 2021 to April 2022.

The inclusion criteria involved children age 6-10 years old, with no systemic disease, had one or more of the primary molars extracted unilaterally prior to normal exfoliation time. On the other hand, any patient who was undergoing Orthodontic treatment or had space maintainer were excluded from the study. After application of these criteria, children enrolled into this study were 95 children.

2.2. Clinical procedures

A clinical oral examination was performed at the dental teaching hospital/ department of Pediatric and Preventive dentistry to determine children with unilaterally lost primary molar(s). Socioeconomic and demographic information were retrieved from each patient in addition to oral health information and time since teeth loss by using a specific clinical form that was fabricated according to WHO criteria [14].

Clinical examination was performed after seating the children involved on the dental chair and by using chair light and dental mirror. K file (Dentsply, Charlotte, North Carolina, USA) and a ruler were used to measure the space available on the extraction side and the mesio-distal dimension of the contra-lateral tooth or teeth on the opposite side in mm. The space was detected from the tip of K file to the stopper.

2.3. Definition and description of the variables

Children were selected who presented with unilateral loss of a primary molar (D and/ or E). The dependent variable was the difference (loss of space in mm) between the opposite side measurement and the extraction side (with loss of a primary molar(s)). Measurements were first generated using three possible scenarios: Measuring the extraction side: 1. For children with prematurely lost D, the distal distance from C to the mesial of E was measured. 2. For children with prematurely lost E, the distal distance from D to the mesial of 6 (permanent first molar) was measured. 3. For children with prematurely lost D & E, the distal distance of C and the mesial distance of 6 (permanent first molar) were measured. The same measurements were made on the opposite side. Subsequently, the measurement results were subtracted as follows: Opposite side – Extraction side, obtaining the difference between these measurements.

The independent variables included in the study were: gender (male, female), age (6–10 years), arch (maxillary and mandibular), Side (right and left) and time since premature tooth loss (Up to 2 months, up to 4 months, up to 6 months, up to 8 months and more than 8 months).

2.4. Statistical analysis:

After checking the normality distribution of the variables by using Shapiro-Wilk normality test, All the variables tested were not normally distributed, thus, non-parametric tests were used.
Univariate analysis was performed to describe the variables that were reported as frequencies and percentages for qualitative variables, and as the mean and standard deviation for quantitative variables. In the bivariate analysis, the influence of the independent variables with respect to the dependent variable was investigated where Wilcoxon signed rank test was used to compare the mean of the space available in the extraction side with that on the opposite side.
Mann Whitney U test was used to check whether gender, arch or side of prematurely lost tooth have an effect on the difference in the mount of space available between the extraction and opposite side.
Finally, Spearman's correlation was used to check the relation of the age and time since lost with the difference in the amount of space available between the extraction and opposite side.
All statistical analyses were performed using the Statistical Package for Social Science for Windows IBM SPSS® (Version 28, SPSS Inc., Chicago III., USA). The significance level was set at p-value ($p<0.05$).

2.5. Ethical issues:

Ethical approval for the research protocol was obtained from the Department committee at the University of Babylon, College of Dentistry, Department of Pediatric and Preventive dentistry.
Written consent was provided by the parents/ guardians of the participating children.

3. Results:

A total of 95 (50 male 52,6% and 45 female 47,4%) children met the inclusion criteria and were examined (Table 3.1). They age 6-10 with a mean of 9.14 ± 1.03.

Of these children, 23 had premature loss of one or more of their primary molars in both arches increasing the measured variables into 118. Premature loss was found to be more prevalent in the lower arch (81.4%) and more frequent on the left side (52.5%) (Table 3.2). Approximately quarter of the children examined (25.4%) had both of the primary molars prematurely lost and the most frequently lost tooth was the lower left primary second molar (22%) (Table 3.3).

Table 3.1: Univariate analysis of gender

Variable		Frequency	Percentage %	Total
Gender	Male	50	52.6	95
	Female	45	47.4	

Table 3.2: Univariate analysis of arch and side of prematurely lost teeth

Variable		Frequency	Percentage %	Total
Arch	Upper	22	18.6	118
	Lower	96	81.4	
Side	Right	56	47.5	118
	Left	62	52.5	

Table 3.3: Univariate analysis of prematurely lost teeth

Prematurely lost teeth	Frequency	Percentage %
Upper right D	3	2.5
Upper right E	6	5.1
Upper right D & E	4	3.4
Upper left D	5	4.2
Upper left E	3	2.5
Upper left D & E	1	0.8
Lower left D	14	11.9
Lower left E	26	22
Lower left D & E	12	10.2
Lower right D	11	9.3
Lower right E	20	16.9
Lower right D & E	13	11
Total	118	100

More than half of the children have reported that they have lost their teeth for a period exceeding 6 months (27.1%) and (28.8%) (Table 3.4).

Table 3.4: Univariate analysis of time since tooth was lost

Time since tooth loss	Frequency	Percentage %
Up to 2 months	26	22
Up to 4 months	16	13.6
Up to 6 months	10	8.5
Up to 8 months	32	27.1
More than 8 months	34	28.8
Total	118	100

After measuring the space on the extraction side and compare it to the space available on the opposite side, about two thirds of the cases (66.1%) have shown space loss on the extraction side (Table 3.5) ranged from 1.7 to 2.3 mm with a mean of 2.01 ± 1.32 (Table 3.6)

Table 3.5: Univariate analysis of space loss

Presence of space loss on extraction side	Frequency	Percentage %
Yes	78	66.1
No	40	33.9
Total	118	100

The mean of the space available on the extraction side (8.99 mm ± 3.4) was significantly lower than that on the opposite side (11.03 mm ± 3.4) ($P < 0.001$) (Table 3.6).

Table 3.6: Bivariate analysis of extraction and opposite side

Amount of space	Mean ± SD	95% CI
Extraction side	8.99 ± 3.4	8.21 – 9.78
Opposite side	11.03 ± 3.4	10.24 – 11.81
Difference	2.01 ± 1.32	1.70 – 2.31

95% CI=95% confidence intervals, SD=standard deviation.

Wilcoxon signed ranks test, $P < 0.001$

When the difference in the amount of space available on the extraction and opposite side was compared to gender, type of arch, and side of prematurely lost teeth; no statistical significant difference was found between these variables. (Table 3.7)

Table 3.7: Bivariate analysis of extraction and opposite side

Variable		Average mean ± SD	P*
Gender	Male	1.97 ± 1.32	0.874
	Female	2.0 ± 1.30	
Arch	Upper	2.09 ± 1.21	0.493
	Lower	1.95 ± 1.34	
Side	Right	2.11 ± 1.25	0.174
	Left	1.83 ± 1.37	

* Mann Whitney U test; P > 0.05

When the time since tooth extracted was compared to the amount of space lost, the correlation for these variables was very weak positive relationship with no statistically significant difference (p value was 0.531). However, there was moderate positive relationship that was statistically significant between the age and the amount of space lost (p: 0.016). (Table 3.8)

Table 3.8: Bivariate analysis of correlation

Variables		Correlation	Relationship	P*
Age	Amount of space lost	0.302	Moderate +ve	0.016
Time since tooth loss	Amount of space lost	0.072	Very weak +ve	0.531

* Spearman's correlation test

4. Discussion:

This study investigated the potential space loss in children aged 6 to 10 years because prior to this stage of mixed dentition, the possibility of primary tooth loss is less, while after the age of 10 years, the permanent premolars will start to erupt. The same age range was studied by Padma & Retnakumari (2006), Cuoghi et al. (1998) & Park et al. (2009) [5, 15 & 16]. This split-mouth study also recruited children who have unilateral space loss in order to use the opposite side as the control side against which the space on the extraction side can be compared with.

It is generally accepted that a disruption in arch integrity of the primary or mixed dentition without space maintenance will lead to a malocclusion that is dependent upon the type and time of tooth loss [7]. The prevalence of space loss was found to be 66.1% and the mean amount of space loss was 2.03 mm with a range of 1.7 to 2.3 mm for all the cases examined which was higher than the average space loss reported by Padma & Retnakumari (2006), Lin et al. (2011) & Lin & Chang (1998) [5, 8 & 17] (1.41, 1.08 & 1.5 mm respectively). This difference in the amount of space loss between the extraction side and the opposite side was statistically significant. This result was similar to the finding of Alexander et al. (2015) [18].

Previous studies conducted by Helm, Owen , and Lin [19, 20, & 21] have shown that the loss of space is more frequent in the mandible than in the maxilla which was coincident with the findings of this study (81.4%). However, the average amount of space loss in mm was not statistically significant which also agree with Lucas-Rincón et al. (2019) [1]. Similarly, neither the gender nor the side of the lost tooth has an effect on the amount of space loss as this was found to be not significant statistically.

Tunison et al. (2008) have found that the mean of the amount of space loss at 2-, 4-, 6- and 8-months intervals was not statistically significant [2]. The same outcome was found in the present study when the mean of space loss at different time intervals was compared. However, the amount of space loss was found to be increased significantly with increasing the age of the child.

Although some authors suggest that space maintainers should be indicated only in cases of premature loss of the second primary molars and should be placed within the first 3 months after such extractions [1], other authors suggest that various factors must govern this situation .The early loss of teeth in the primary dentition has different consequences based on which teeth are lost and the existing alignment and occlusion [4]. However, it is important to identify the risk factors and reduce the premature loss of the primary teeth.

Although space loss was significant following premature extraction of primary molars, this loss may not have clinical implications as several other factors may be overlapped. These factors include: eruption sequence and extraction timing and space condition, skeletal and muscular characteristics, periodontal factors and craniofacial growth as well as the existence of leeway space. Increased curve of spee and teeth protrusion. Thus, the clinical significance of space lost and the need for space maintenance may only be determined after comprehensive assessment of

the various characteristics of each individual case and should not be considered only in view of apparent space loss [2]

5. Conclusions:

From the results of the study, the following can be concluded:

1- The prevalence of space loss following premature extraction of primary molars is high.

2- The premature extraction of primary molars in the mixed dentition resulted in statistically significant space loss in the extraction side compared to the opposite side.

3- Space loss in the lower arch was more frequent than that in the upper arch.

6. Recommendations:

- The results of this research should reinforce the importance of prevention of dental caries and premature loss of primary molars, and its impact on the development of a sound child's occlusion.

- Further studies are required to assess further arch perimeters on study models to suggest whether space maintainer is required or not.

7. References:

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