Interproximal caries and premature tooth loss in primary dentition as risk factors for loss of space in the posterior sector

A cross-sectional study

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Abstract

Dental caries—a highly prevalent public health problem in preschoolers and school children—is the main cause of premature dental loss during childhood, and this may be related to loss of space in the posterior sector. The objective of this study was to evaluate whether interproximal caries and premature tooth loss (D and/or E) are risk factors for loss of space in the posterior sector.

A comparative cross-sectional study (split-mouth type) was performed in schoolchildren (6–8 years old). Seventeen gypsum models were evaluated. These children presented with unilateral loss of a dental organ or interproximal caries (teeth D and/or E) and without such affectations on the other side. Measurements were made with a digital Vernier caliper. The dependent variable was the difference (loss of space, mm) between the control and case sides. The independent variables were type of affectation (interproximal caries or tooth loss), sex, age, arcade, and number of interproximal surfaces affected.

The mean age was 6.82 ± 0.44 years and 64.7% were boys. The average space loss was 1.09 ± 0.18 mm (control vs case; $P < .0001$). A greater loss of space was observed among those who lost a dental organ than those with interproximal caries ($P = .0119$). A correlation was observed between the variable loss of space and the number of interproximal surfaces affected ($r = 0.5712$, $P = .0166$).

Interproximal caries and tooth loss were risk factors for loss of space in the posterior segment in this sample of Mexican schoolchildren.

Abbreviations: 95% CI = 95% confidence interval, mm = millimeters, SD = standard deviation.

Keywords: dental caries, loss of space, loss of teeth, oral health, schoolchildren

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1. Introduction

Generally, oral diseases and alterations are frequent and represent real oral health problems, affecting approximately 3.9 billion people around the world. Untreated dental caries in the permanent dentition affects 35% of people in all age groups worldwide. However, untreated dental caries in primary teeth affects 9% of the world's population. The main consequence of dental caries is tooth loss, which is also a prevalent oral condition.[1–3] Dental caries is a disease of the hard tissues of the tooth, and it is caused by an imbalance in the demineralization and remineralization processes on dental surfaces.[4] Over the past decades, evidence has accumulated in several countries about the decrease in the prevalence and severity of this disease, and also an increasing number of caries-free individuals. However, dental caries continues to affect many children.[5] In Mexico, dental caries is a public health problem that is present in preschoolers and school children; it is highly prevalent and considered to be the main cause of premature dental loss during childhood.[6–8]

In developing countries such as Mexico, where access to and provision of dental health services is limited because of the lack of supplies, dental extraction is often the treatment of choice for primary teeth.[9] Premature tooth loss has been defined as the loss of a dental organ before the time of natural exfoliation.[10] Studies conducted around the world on premature tooth loss

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reveal a prevalence ranging from 8.5% to 51.0%.[6] The most common cause of this event is dental caries, and other factors reported include trauma, ectopic eruption, congenital disorders, and orthodontic considerations.[11–13] Premature loss can cause difficulty with the proper development of mastication, and also disorders in phonation and a decrease in the perimeter of the temporary dental arch, favoring alterations in craniofacial growth. In particular, a reduction in the length of the dental arch can cause crowding and tooth impaction, and increase the need for orthodontic treatment.[14–17]

Law[18] mentions, in a recent review, that previously published results are controversial regarding the effects of early loss of primary first molars. The loss of space occurs within the first 4 to 6 months after extraction. There is migration of the primary canines and permanent incisors to the edentulous space in both arches, and a minor mesial movement of the upper second primary molars occurs. Loss of space can result in blocked permanent canines, which most commonly occurs in the maxilla. There is no statistically significant loss in arch width, length, and perimeter after the loss of the first primary molars. However, the early loss of primary second molars is less controversial. There is a high probability of space loss, with a greater loss of arch length in the maxilla than in the mandible. The most serious space problems occur when the primary second molars are exfoliated or lost before the eruption of the permanent first molar, where its eruption in the oral cavity is guided by the distal surface of the primary second molars. Additionally, the loss of posterior space is greater in the jaw than in the maxilla, because the loss of contact points resulting from interproximal caries is more frequent.[11,18,19]

The objective of this study was to determine whether interproximal caries and premature tooth loss (D and/or E) are risk factors for the loss of space in the posterior sector in a sample of Mexican schoolchildren.

2. Materials and methods

2.1. Design, population, and study sample

A comparative cross-sectional study was performed in schoolchildren who were 6 to 8 years old. The characteristics of the design are: observational, cross-sectional, comparative, and retrospective. The study included students from a public school in a community in Hidalgo, Mexico. The field work was performed in June, 2016. The sample size calculation was performed using the following parameters: expected difference of 2 mm, difference in the standard deviation of 0.5 mm, alpha of 0.05, and power of 0.90, which resulted in a sample size of 15 children. The inclusion criteria were: student was enrolled in the selected school; male or female; age 6 to 8 years; parents provided informed consent; and child who had unilateral interproximal caries or tooth loss that affected a primary upper or lower molar. The exclusion criteria were: the child was undergoing orthodontic and/or orthopedic treatment; had a space maintainer; presented with dental abscess/infection; refused to be clinically evaluated; and was not possible to make the impression. Initially, 287 children were reviewed, and among them, children who met the inclusion and exclusion criteria were selected, resulting in a final sample of 17 schoolchildren, from whom gypsum models were evaluated.

2.2. Clinical procedures

A clinical oral examination was performed to determine those children that were unilaterally with tooth loss or affected by interproximal caries. The exploration was performed in a suitable place inside the school under natural light using a mirror, and gloves and a mask were also used.

An impression was make of children's teeth in the selected group, using alginate (Kromopan, LASCO Spa, Florence, Italy) and a metal frame tray, which were sterilized and disinfected. Plaster type 4 (Whip mix, Whip Mix Corporation, Louisville, KY) was then poured into the mold. The measurements on the gypsum models were made using a digital Vernier caliper (CD-6" CSX, Mitutoyo Corporation, Kawasaki, Japan).

2.3. Definition and description of the variables

2.3.1. Dependent variable. Children were selected who presented with unilateral loss of a dental organ or interproximal caries in teeth D and/or E, and these subjects also had no such affectations on the opposite side. The dependent variable was the difference (loss of space in mm) between the control side measurement (healthy) and the case side (with loss of a dental organ or interproximal caries). The dependent variable was calculated in the gypsum models as described below. Two measurements were first generated using three possible scenarios:

Measuring the case side:

1. For children in whom tooth D was affected, the distal distance from C to the mesial of E was measured.
2. For children in whom tooth E was affected, the distal distance from D to the mesial of 6 (permanent first molar) was measured.
3. For children in whom teeth D and E were affected, the distal distance of C and the mesial distance of 6 (permanent first molar) were measured.

The same measurements were made on the control side. Subsequently, the measurement results were subtracted as follows: case side-control side, obtaining the difference between these measurements (Fig. 1).

The independent variables included in the study were: sex (boys, girls), age (6–8 years), arcade (upper or lower), type of

Figure 1. Figure that illustrates the anatomical points. Central point of the mesial surface of tooth 6, central point of the mesial surface of the tooth E, and most distal point of the distal face of tooth C. The measurements were made directly in the gypsum models with an electronic vernier.

affectation (interproximal caries or tooth loss), and number of affected surfaces (0–4).

The intraexaminer error was calculated based on double measurements of 10 randomly selected cast at 2 different times, performed by 1 previously trained and standardized observer. The error was less than 0.3 mm and was not statistically significant ($P > .05$).

2.4. Statistical analysis

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 paired Student t tests, the Student t test and Pearson correlation were applied, based on the variables tested. The statistical analysis was performed using Stata 11 (StataCorp, TX). The level of significance $P < .05$ was considered to be significant.

2.5. Ethical issues

This study was performed in accordance with the general law of health in research and the scientific principles of the Declaration of Helsinki. The protocol was approved by the ethics and research committee of the Advanced Studies and Research Center in Dentistry in the Faculty of Dentistry at the Autonomous University in the State of Mexico. The privacy and confidentiality of the participants in investigation was protected. The anonymity of the people who provided the data was guaranteed, avoiding its use for purposes other than those authorized by their parent or legal guardian. Written consent was provided by the parents/guardians of the participating children.

3. Results

There were 17 children between 6 and 8 years of age who were enrolled into this study. Table 1 shows the results of study sample characteristics analysis. The participants were 64.7% male and their mean age was 6.82 ± 0.44 years. Interproximal caries had a 88.2% prevalence, and tooth loss was present in 11.8% of

Table 2

Bivariate analysis of the case and control sides.

Variable	Mean ± SD	95% CI
Control side	17.97 ± 0.94	17.49–18.46
Case side	16.88 ± 1.19	16.27–17.49
Difference (mm)*	1.09 ± 0.76	0.70–1.49

95% CI = 95% confidence intervals, SD = standard deviation.
Paired Student t tests, $P < .0001$.
* Refers to the loss of space in the posterior sector.

participants. Interproximal caries or tooth loss was most often present on the right side, with 52.9% of participants showing this affectation. For the variable arcade, the lower arcade was most often affected, with 52.9% of patients showing lower arcade involvement. Additionally, there was an average of 2.23 ± 1.15 affected surfaces (assessing the mesial and distal faces of the molars).

Table 2 shows the results of the comparison between the control and case sides. We observed that there was a significant difference between the control and case measurements ($P < .0001$).

The results of the bivariate analysis are presented in Table 3, in which the variable "difference" (or loss of space) is compared with the independent variables in the study. For the type of affectation (interproximal caries or loss of teeth), the average difference between schoolchildren who presented with tooth loss was greater than in those who presented with interproximal caries ($P = .0119$). A correlation was observed between the variable difference and the number of interproximal surfaces affected ($r = 0.5712$, $P = .0166$), which means that the greater the number of affected surfaces, the greater is the loss of posterior space. There was no statistically significant difference observed for sex, type of arch, or age.

4. Discussion

This study evaluated the relationship between the loss of posterior space and 2 events that are of clinical importance in pediatric dentistry: interproximal caries and tooth loss (both in molars). The loss of posterior space also had a close relationship with the type of condition (proximal caries vs tooth loss), and also with the number of affected surfaces. As in Mexico,[6,20,21] studies performed in other countries showed that tooth decay and

Table 1

Univariate analysis of the characteristics.

Variable	Frequency	Percentage
Sex		
Boys	11	64.7
Girls	6	35.3
Type of affectation		
Interproximal caries	15	88.2
Tooth loss	2	11.8
Arcade		
Lower	9	52.9
Upper	8	47.1
Site affected		
Right	9	52.9
Left	8	47.1
	Mean ± SD	Range
Age (y)	6.82 ± 0.44	6–8
Number of affected surfaces	2.23 ± 1.15	1–4

SD = standard deviation.

Table 3

Bivariate analysis between the dependent variable (difference between case and control sides) and the independent variables.

Variable	Average mean	P
Sex		
Boys	1.13 ± 0.83	
Girls	1.02 ± 0.69	.7929
Type of affectation		
Interproximal caries	0.93 ± 0.49	
Tooth loss	2.3 ± 1.63	.0119
Arcade		
Lower	1.30 ± 0.97	
Upper	0.86 ± 0.37	.2380
	Correlation	P
Age (y)	$r = 0.2122$	.4135
Number of affected surfaces	$r = 0.5712$	.0166

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early tooth loss represent a public health problem among school-age children.[10,12–15,22–24] The premature loss of a temporary molar affected by caries before the eruption of the first permanent molars causes significant mesial movement of the first permanent molar or the second primary molar, which are mesialized at the moment of the eruption, using the available space and thereby reducing the arc length. This leads to a collapse of the arcade.[25]

To avoid loss of space when a tooth is lost, the American Academy of Pediatric Dentistry recommends placing a space maintainer. The objectives of space maintenance are to prevent the loss of the arch length, and/or the perimeter of the arch, maintaining the relative position of the existing dentition.[26] Previous studies show that the loss of space is greater in the mandible than in the maxilla if a second primary molar is lost compared with a first primary molar,[11] and the greatest amount of space loss was observed in the first 6 months after the loss of the dental organ.[27] In the present study, the lower arcade showed the greatest loss of space (in mm), although this change was not significant ($P > .05$). In the present study, the time of tooth loss was not established, and this could be a variable that also affects this relationship.

The present study has some limitations that must be taken into account for an adequate interpretation of the results. We could not accurately measure the time at which the participants had lost the tooth or the time at which the interproximal caries had presented, which could have yielded clinically relevant data. This study has methodological strength, because the same participant was used as a case and control (split-mouth study), where all the variables related to the participant are controlled. However, it was difficult to locate participants with this characteristic. Additionally, in contrast with longitudinal studies, there may be an ethical dilemma with follow-up, because in those the researchers do not perform the necessary treatment (space maintainer) on children who lost teeth.

The use of preventive and interceptive orthodontic appliances is intimately related to a fundamental knowledge of anatomy and physiology.[28] 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,[29] other authors suggest that various factors must govern this situation.[18,28] The early loss of teeth in the primary dentition has different consequences based on which teeth are lost and the existing alignment and occlusion.[18] However, it is important to identify the risk factors and reduce the appearance of interproximal caries, and also premature loss of the primary teeth, such as the adverse effect of loss of posterior space, by making the parents aware and providing information on the importance of preserving the primary dentition.

5. Conclusions

Interproximal caries and tooth loss are risk factors for the loss of space in the posterior segment in Mexican schoolchildren. It is necessary that decision-makers consider this problem to be a priority and promote preventive programs.

Why this paper is important

- Knowledge about aetiological factors of loss of space in the posterior segment is essential to take clinical decisions for the affected population and to establish a protocol for diagnosing and treating.

- Despite advances in prevention, the prevalence of children with dental caries (coronal and interproximal) and premature loss of primary molars is high, with clinical consequences as the loss of space in the posterior segment.
- The results of this article should reinforce the importance of prevention of dental caries and premature loss of primary molars, and its impact on the development of a sound infant occlusion.

Author contributions

S.E.L.R., N.L.R.B., E.L.C., and C.E.M.S. were involved in the design and development of the study. S.E.L.R. and C.E.M.S. performed the literature review did the analysis of the data and wrote the first draft of the manuscript. R.J.S.V., A.P.P.L., V.R.I., J.P.L.R, and M.E.R. were involved in the conception of the paper, analysis and interpretation of the results. All the authors were involved in the critical review and made intellectual contributions, they also accepted the final version.

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