Caries Progression Rate in Primary Teeth: A Retrospective Study

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***Objectives**: The rate of caries progression in primary teeth has rarely been studied, with most studies on early childhood caries reporting the percentage of lesions that remain at a certain stage of disease over a period of time. The aim of the present study was to examine the prevalence and behavior of proximal and occlusal carious lesions in primary teeth among children from low socio- economic status. **Study design:** This retrospective study was based on bite-wing radiographs of 95 children aged 5- 12 taken at 6-12 months intervals, with a follow-up period of at least three years. One hundred thirty-five teeth and 141 tooth surfaces were examined. The degree of proximal surfaces and occlusal caries advancement was scored and statistical analyses (Mann-Whitney, Kruskal–Wallis and Kaplan-Meier analysis) were performed to evaluate caries progression rate. **Results:** The results revealed that approximately 0.8 years were required for a carious lesion to progress from the outer enamel to the dentino-enamel junction, and an additional 1.4 years for it to reach the inner part of the dentin. **Conclusions:** The caries progression rate found in the present study is more rapid than previously found and affects more the lower socio economic population.*

***Key words:** proximal caries, caries progression, primary teeth.*

INTRODUCTION

In the permanent dentition the progression of caries through the proximal and occlusal surfaces is slow[1-5], both through the enamel[2,6,7] and beyond the enamel-dentin border[2]. Although caries- related events in the proximal surfaces of teeth were found to differ from those in permanent teeth[8-10] the rate of caries progression in primary teeth has rarely been studied.

Most studies on early childhood caries reported the percentage of lesions that remain at a certain grade over a period of time, but did not attempt to estimate the time needed for carious lesions to progress from the enamel into the outer and inner zones of the dentin[9,10]. These studies mostly reported a low caries progression rate[9,10]. A study conducted on children from low socio—economic status in Florida, U.S.A found a relatively high prevalence of cavitated teeth[11].

The American Academy of Pediatric Dentistry (AAPD) guidelines on contemporary management of dental caries advocate identification of an individual's risk for caries progression, understanding of the disease process for that individual and maintaining "active surveillance" to assess disease progression[12]. The guidelines state patients of low socio-economic status are at high risk for caries progression [12].

The aim of the present study was to explore the occurrence and progression rate of proximal and occlusal carious lesions in primary molars among children from low socio— economical class.

MATERIALS AND METHOD

Study protocol was approved by the Institutional Human Subjects Ethics Committee of Hadassah Medical Organization IRB, Jerusalem, Israel.

This retrospective study was based on dental records of healthy children aged 5- 12 years treated at the Dental Volunteers for Israel (DVI) Clinic in Jerusalem, Israel between the years 1997-2007. The clinic treats children aged 5–18 from families of low socio—economical class free-of-charge and includes a mandatory oral hygiene program. Fluoridation status of Jerusalem water had been varied during that period between adequately to partially fluoridated.

Inclusion criteria: age: 5-12 years, three or more pairs of bite-wing radiographs of good quality without overlaps, taken at 6-12 months intervals, with a follow-up period of at least three years. Occlusal caries progression rate was evaluated based on the dental records.

Excluded from the study were teeth that had been treated less than a year after the first radiograph and teeth that had been treated before the carious lesion had reached the dentin. Consequently, most teeth included in the study were teeth in which the carious lesion was either undetected or monitored or treatment was not performed due to lack of patient cooperation in attending treatment appointments.

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With the significance level set at 5% (1-tailed) and 90% power, it was calculated that a total of 86 records would be needed for the study (the details of the power analysis are described in the statistical analysis section). Examination of 1052 dental records yielded 95 dental records that fulfilled study inclusion criteria.

Study population consisted of 95 children aged 5-12 years (average 6.9, median 6.7) at baseline, 51 girls (54%) and 44 boys (46%). Children's gender and age at baseline were recorded.

Bitewing radiographs were scored for the occurrence and progression of enamel and dentin caries. The accuracy of bitewing radiographs in caries detection has been long established[13]. All data were collected by a single trained disinterested investigator (R.A) with an intra-rater reliability found to be Kappa=0.8 ($p<0.01$) using a standard light table. Data were saved in an Excel program.

Mesial, distal and occlusal surfaces of the first and second primary molars were scored at every examination date.

The degree of proximal surfaces and occlusal caries advancement was classified according to a scoring system previously utilized by *Mejàre et al* (1999, 2001)[2,14]:

> **0** = No visible radiolucency. **1** = Radiolucency in the outer half of the enamel. **2** = Radiolucency in the inner half up to the dentino-enamel junction (DEJ). **3** = Radiolucency with a broken enamel-dentin border but with no obvious dentin involvement. **4** = Radiolucency with obvious spread in the outer half of the dentin. **5** = Radiolucency in the inner half of the dentin.

Statistical analysis

As the study population was comprised exclusively of children with carious lesions in primary teeth, no assumption was made of a normal distribution of caries prevalence in the population. Consequently, only non- parametric tests for significance were performed.

A one-tailed t-test was used in the follow up of carious teeth because deviations in only one direction (i.e. the *progression* of carious lesions) are considered possible. In line with the results of previous studies[1,9,15] that found a relatively small effect of time on caries progression in children and adolescents, we expected a small effect size (0.2) of time on caries progression rate (from score 0 to 1, from score 1 to 2 etc.) in the present study. Based on this assumption, power analysis calculations indicated that for a significance level of 5% and a power of 0.9 a minimal sample of 86 children is needed.

Linear regression was used to test the hypothesis that individuals with more than one decayed tooth are liable for a higher caries progression rate and may thus influence the overall caries progression rate in the study population.

Mann-Whitney (Wilcoxon rank-sum) nonparametric test was used to assess if the caries score for each tooth has changed from the previous appointment and to compare caries progression degree between gender groups. Caries progression rate was calculated as the grade of the carious lesion at day x post the initial detection. Follow-up appointments were conducted at six months intervals, depending on families' co-operation.

Kruskal–Wallis test was then used to check for statistically significant differences between the three tooth surfaces (mesial, distal and occlusal) regarding caries degree during the follow-up period.

Kaplan-Meier analysis was used to estimate the survival of teeth surfaces with an initial caries stage score of 0 or 1. It shows caries condition as a function of time post initial examination. The Y axis demonstrates the caries condition. This axis maximal value 1.0 stands for the carious conditions that do not necessitate treatment, while the minimal value 0 stands for carious lesion that reached the pulp. The X axis shows time in days from initial examination. Each dot on the graph indicates the time post initial examination it took a carious lesion in an initial stage to reach a specific carious degree.

The software used for statistical analysis was IBM® SPSS® Statistics version 20 for Windows.

RESULTS

Bitewing radiographs of 135 teeth were included in the study. 141 tooth surfaces were examined.

Linear regression test found no statistically significant difference in caries progression rate between children with one carious tooth to those with more than one carious tooth. Mann-Whitney nonparametric test demonstrated that for all teeth surfaces the most prevalent (47.9% of the teeth surfaces) rate of caries progression between the first and second appointment was 1 (i.e. the teeth had gone from score 0 to 1 or from 1 to 2, etc.). This low rate of caries progression was found in 42% of all mesial surfaces, 50% of all distal surfaces, and 66.7% of all the occlusal surfaces. The higher rate of caries progression, rate 2, meaning the teeth condition had deteriorated from score 0 to 2 or from 1 to 3, etc., had a prevalence of 22.0%, 23.8% and 16.7% for the mesial, distal and occlusal surfaces, respectively. Rate 3 of caries progression (i.e. from score 0 to 3 or from 1 to 4, etc.) had a prevalence of 12.0%, 9.5% and 0% for the mesial, distal and occlusal surfaces, respectively. The highest rate of caries progression, rate 4, meaning the teeth had gone from score 0 to 4 or from 1 to 5, had a prevalence of 2% for the mesial and 0% for the distal and occlusal surfaces. Prevalence of caries development rates is illustrated in figure 1.

The pattern of caries progression rates between the 2nd and 3rd appointments was very similar to that of the prevalence of caries progression rates between the 1st and 2nd appointments with rate 1 being the most prevalent (49.6%), and similar for the three surfaces-followed by rate 2 (20%, 25.9% and 0% for the mesial, distal and occlusal surfaces, respectively) and rate 3 (8%, 8.2% and 0% for the mesial, distal and occlusal surfaces, respectively). Rate 4 was the least prevalent (figure 2).

No statistically significant differences were found between the three tooth surfaces (mesial, distal and occlusal) regarding caries progression rate (p-value= 0.804). However, there was a statistically significant difference in caries progression rate between the occlusal surfaces and the two other surfaces (p-value =0.024).

There was no statistically significant difference in caries progression rate between the distal and mesial surfaces (p-value =0.12), and between the mesial and occlusal surfaces (p-value = 0.099) but there was a statistically significant difference in caries progression rate between the distal and occlusal surfaces (p-value =0.014).

Kaplan-Meier estimate demonstrated the survival curve for teeth surfaces with an initial stage of 0 or 1 (Figure 3). The results indicate that 10 months (300 days) post examination of a carious lesion in an initial stage (i.e. no visible radiolucency or radiolucency in the outer half of the enamel) the lesion will reach stage 2 (0.8 in the Y axis;

Figure 1: Caries progression rates in mesial (M), distal (D) and occlusal (O) surfaces between 1st and 2nd (6-12 months interval) appointments. Zero (0) means the carious lesion did not progress. 1 means the teeth had gone from score 0 to 1 or from 1 to 2, etc. 2 means the teeth had gone from score 0 to 2 or from 1 to 3, etc. 3 means the teeth had gone from score 0 to 3 or from 1 to 4 etc. 4 means the teeth had gone from score 0 to 4 or from 1 to 5.

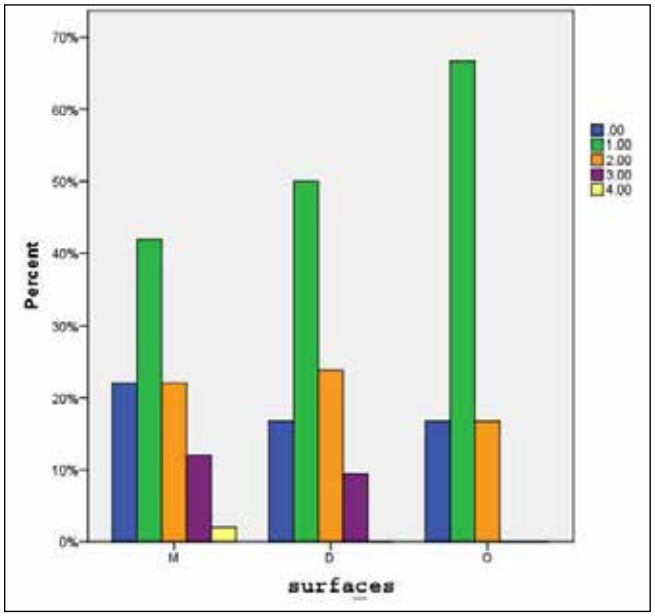


Figure 2: Caries progression rates in mesial (M), distal (D) and occlusal (O) surfaces between 2nd and 3rd (6-12 months interval) appointments. Zero (0) means the carious lesion did not progress. 1 means the teeth had gone from score 0 to 1 or from 1 to 2, etc. 2 means the teeth had gone from score 0 to 2 or from 1 to 3, etc. 3 means the teeth had gone from score 0 to 3 or from 1 to 4 etc. 4 means the teeth had gone from score 0 to 4 or from 1 to 5.

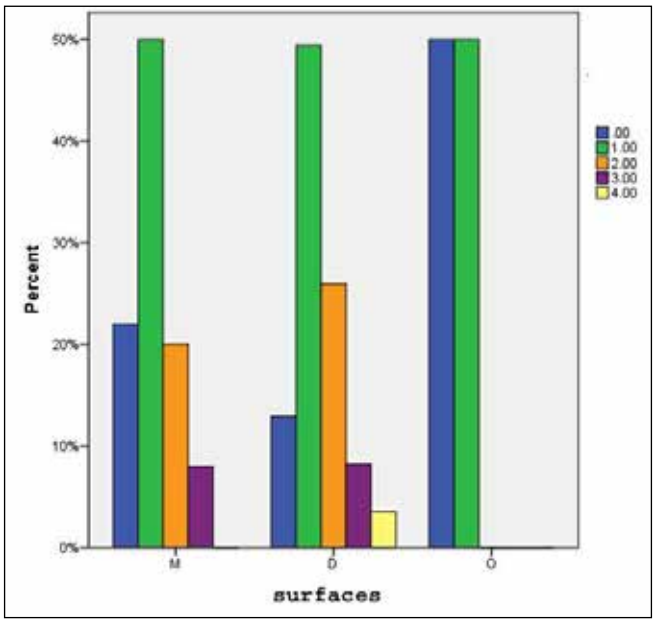
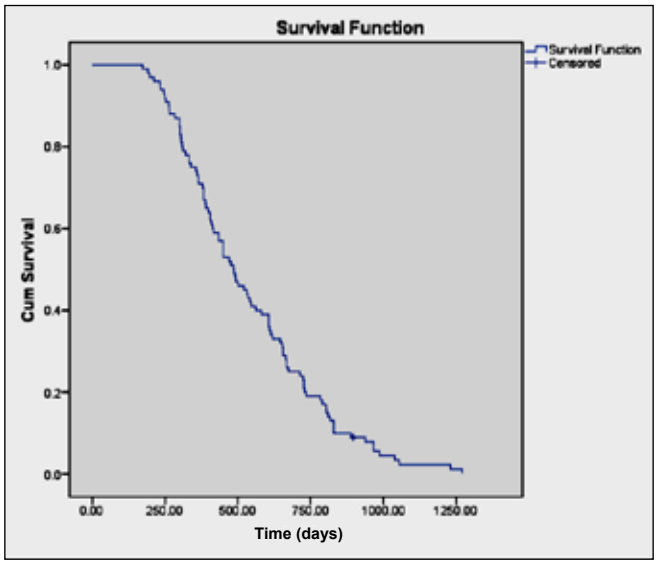


Figure 3: Kaplan-Meier estimate for the survival of teeth surfaces with an initial stage of 0 or 1. The Y axis demonstrates the caries condition: 1.0 stands for the 0 and 1 in the scale of caries progression degrees meaning carious conditions that do not necessitate treatment, while 0 in the graph stands for carious lesion that have reached the pulp. The X- axis shows time in days. The white dot indicates the time post examination it takes a carious lesion in an initial stage (300 days) to reach stage 2 (0.8 in the Y axis) and require treatment. The red dot indicates the time the carious lesion will reach the inner half of the dentin (800 days post initial examination).



radiolucency with a broken enamel dentin border) and require treatment. If not treated, the tooth will have radiolucency in the inner half of the dentin 800 days (~2.2 years) post initial examination.

The Kaplan-Meier estimate showed that it took approximately 1.4 years (500 days) for a carious lesion to progress from the dentino-enamel junction to the inner part of the dentin.

No statistically significant gender differences were found regarding caries progression rates.

DISCUSSION

To the best of our knowledge the present study is one of the first attempts to measure caries progression rate in primary teeth of children of low socio- economic status. Progression of proximal caries in the mixed dentition in school children has been monitored by two former studies[1,15]

The caries progression rate found in the present study was accelerated compared with previous reports. While former studies found that it took approximately three years for lesions to progress from external-third of the dentin to the pulp[1,15], in the present study it took only about 1.4 years (500 days) for the carious lesion to progress from the dentino-enamel junction to the inner half of the dentin. It should be noted that Arrow (2007) found a variance of caries progression rate, with 10 per cent of enamel lesions that had progressed into dentine within 10 months[1].

We speculate that the accelerated caries progression found in the present study may be explained by the low socio- economic status of the study population. Caries is more prevalent in lower than in higher social classes[16,17], and children from low socio-economic

status are considered at high risk for developing caries according to the guidelines of the American Academy of Pediatric Dentistry[12].

The present study found differences in caries progression rate between the proximal and the occlusal surfaces. Other studies[2,7,10] that documented caries rate found the occlusal surfaces to have a higher prevalence of caries.

No statistically significant gender differences were found regarding caries progression rate. This is in agreement with the findings of Arrow (2007)[1], who reported that although boys had a 35 percent lower hazard for occurrence of enamel caries than girls, caries progression was unaffected by gender[1].

The results derived from the Kaplan-Meier analysis regarding the average time it takes a lesion to progress from one state to another should be regarded as an estimation, as the time needed for a lesion to progress from one state to another is extremely variable not only between individuals but also between lesions of the same individual[2,15,18].

CONCLUSION

Our results suggest that children from low socio- economic status may have accelerated caries progression compared with children from higher socio- economic status. Further studies are needed to establish if such a tendency exists in children of low socio- economic status.

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