Braz Oral Res
2006;20(4):358-63

Association between clinical parameters and the presence of active caries lesions in first permanent molars

Associação entre parâmetros clínicos e a presença de lesões ativas de cárie em primeiros molares permanentes

Juliana Maria Quaglio*
Marcela Bernardes Sousa*
Thiago Machado Ardenghi**
Fausto Medeiros Mendes***
José Carlos Pettorossi Imparato***
Sérgio Luiz Pinheiro**

ABSTRACT: The aim of the present study was to evaluate the association between clinical parameters and the presence of active caries lesions on the occlusal surface of first permanent molars. Forty eight children (5.8-13.8 years-old) with at least one first permanent molar present were selected. The clinical parameters evaluated were gender, age, DMF-T and dmf-t, presence of active white spots in other teeth, general plaque index, tooth's dental arch (upper or lower), tooth's side (right or left), presence of visible plaque and eruption degree of the first permanent molars. The first permanent molars were evaluated through visual inspection by two examiners in order to assess the presence of active or inactive caries lesions on the occlusal surface. Univariate and multivariate analyses for determination of the association between clinical parameters and the presence of active caries lesions in these teeth were performed. The presence of active white spots in other teeth was associated with the presence of active caries lesions in the first permanent molars, in both univariate and multivariate analyses (Odds ratio = 8.8 and 1.9, respectively). The presence of abundant visible plaque on the occlusal surface of the first permanent molars (Odds ratio = 3.5 in the univariate analysis, and 3.9 in the multivariate one) also presented a significant association. In conclusion, the presence of active white spots in other teeth and the presence of considerable visible plaque were associated with the presence of active caries lesions on the occlusal surfaces of first permanent molars.

DESCRIPTORS: Dental caries; Dental caries activity tests; Diagnostic techniques and procedures.

RESUMO: O objetivo do presente trabalho foi avaliar a associação entre parâmetros clínicos e presença de lesões ativas de cárie sobre a superfície oclusal de primeiros molares permanentes. Quarenta e oito crianças (5,8-13,8 anos) com pelo menos um primeiro molar permanente foram selecionadas. Os parâmetros clínicos avaliados foram sexo, idade, CPO-D e ceo-d, presença de manchas brancas ativas em outros dentes, índice de placa, arco dentário do dente (superior ou inferior), lado do dente (direito ou esquerdo), presença de placa visível e grau de erupção dos primeiros molares permanentes. Os primeiros molares permanentes foram avaliados usando inspeção visual por dois examinadores para avaliar a presença de lesões de cárie ativas ou inativas sobre a superfície oclusal. Análises univariada e multivariada para avaliação da associação dos parâmetros clínicos e presença de lesões ativas nesses dentes foram realizadas. A presença de manchas brancas ativas em outros dentes apresentou associação significante com a presença de lesões ativas de cárie nos primeiros molares permanentes, em ambas as análises univariada e multivariada ("Odds ratio" = 8,8 e 1,9, respectivamente). A presença de placa visível abundante sobre a superfície oclusal dos primeiros molares permanentes ("Odds ratio" = 3,5 na análise univariada, e 3,9 na análise multivariada) também apresentou associação significante. Em conclusão, a presença de manchas brancas ativas em outros dentes e a presença de placa visível abundante apresentaram associação com a presença de lesões ativas de cárie sobre a superfície oclusal dos primeiros molares permanentes.

DESCRITORES: Cárie dentária; Testes de atividade de cárie dentária; Técnicas de diagnóstico e procedimentos.

* Graduate Students; **Assistant Professors – Department of Pediatric Dentistry, School of Dentistry, Hermínio Ometto University Center, Araras, Brazil.
*** Assistant Professors, Department of Pediatric Dentistry, School of Dentistry, University of São Paulo.

INTRODUCTION

The diagnosis of dental caries has been traditionally limited to caries lesions detection which classified them based on physical criteria such as size and presence of cavitation.[18] However, since dental caries is a highly dynamic process, the diagnosis of caries activity is essential for a correct treatment decision.[9,17,18]

The assessment of caries activity comprises the evaluation of etiological factors associated with the clinical examination of caries lesions.[2] Bacterial plaque, tooth and other biological factors act as determining factors of dental caries, along with several behavioral and socioeconomic factors which influence caries development.[11] Regarding the assessment of caries lesions activity, longitudinal studies could evaluate the progression of lesions. Nevertheless, clinical changes assessed by visual inspection would be only detected after two or three years, and, for ethical reasons, dentists could not leave the caries lesions with no intervention in this period. Therefore, many authors have proposed diagnostic criteria based on a single visual inspection for distinguishing active and arrested caries lesions.[9,10,20]

A set of clinical diagnosis criteria to assess caries lesions activity has been proposed with good reliability,[20] and it presented construct and predictive values in previous studies.[19] However, there are some difficulties involved in using this visual score system in clinical practice. For that particular reason, examiners should be extensively trained to achieve a good reliability in distinguishing active and arrested caries lesions,[10,20] because visual inspection is a qualitative and subjective method. Thus, evaluation of some clinical parameters associated with caries lesions activity could be helpful for a correct examination by clinicians.

The more susceptible teeth to dental caries are the first permanent molars. These teeth have a longer eruption time, and dentists must be careful in this period.[8] They should also be able to perform an accurate assessment of caries lesions activity in these teeth, which will be crucial to establish correct management and preventive approaches. Thus, the aim of this study was to evaluate the association between several clinical parameters and the presence of active caries lesions assessed by visual inspection on the occlusal surface of first permanent molars.

MATERIAL AND METHODS

The Ethical Committee of the São Leopoldo Mandic Dental College, Campinas, Brazil, approved the study. Informed consent forms were signed by the patients' parents.

Examiners' training

Prior to the clinical examinations, two examiners (MBS and JMQ) were trained for two weeks to perform visual inspection according to the criteria described by Nyvad *et al.*[20] (1999). The training was performed with practical exercises using pictures of representative teeth for each visual score. Thereafter, the examinations were performed in five children until the two examiners reached a consensus.

Sample selection and clinical examination

Forty eight children (range = 5.8-13.8 years old), living in Araras, Brazil, who had at least one erupted first permanent molar, participated in this study.

The examinations were carried out in a conventional dental chair under standard illumination. The children attended twice for examination. During the first examination, one examiner used the simplified plaque index[13] in order to obtain an overview of the oral hygiene condition. The presence of visible plaque on occlusal surfaces of first permanent molars was detected using the criteria previously described.[9] The teeth were then cleaned using a rotating bristle brush with pumice/water slurry and rinsed with water. After that, the examiner evaluated the DMF-T and dmf-t for each patient, considering decayed only the cavitated teeth. The presence of active white spots in other teeth was also recorded.[20] The eruption degree of the first permanent molars was recorded according to the index described by Ekstrand *et al.*[8] (2003).

In the second examination, first permanent molars were cleaned again, and two examiners performed a visual inspection of the occlusal surfaces of the first permanent molars according to the visual score system proposed in a previous study.[20] The examiners were orientated to analyse each tooth independently.

During the examinations, all subjects were positioned in a dental unit and were examined using an operating light, a 3-in-1 syringe, cotton rolls, a plane buccal mirror and a non-sharpened explorer.

First permanent molars with restorations or fissure sealants, hypoplastic pits, an advanced degree of fluorosis, frank occlusal cavitation or large carious lesions on smooth or proximal surfaces were excluded. The total number of first permanent molars included in the study was 151.

Statistical analysis

Ten children were examined twice by one examiner with an interval of one week between each examination to assess intra-examiner reliability of clinical parameters. Cohen's Kappa statistics coefficient[6] was used to assess intra-examiner reliability and the values were classified according to the interpretation proposed in an earlier study.[16]

Inter-examiner reproducibility of the visual inspection of the first permanent molars was also assessed using Cohen's kappa coefficient at the tooth level.[6] Reliability was calculated using all seven scores of visual index. Thereafter, reproducibility was calculated by comparing categories as follows: Sound teeth (score 0) *vs.* carious teeth (scores 1 to 6); and sound teeth and teeth with inactive caries lesions (scores 0, 4, 5, and 6) *vs.* active caries lesions (scores 1, 2, and 3).

A univariate analysis was performed to assess the association between the studied clinical parameters – age, gender, general plaque index, visible plaque on occlusal surface of first permanent molars, eruption degree of first permanent molars, arch position of the tooth (upper or lower, right or left), active white spots caries lesions in other teeth, and DMF-T and dmf-t – and the presence of active caries lesions clinically assessed on the occlusal surface of the first permanent molars. Odds Ratio (OR) and 95% confidence interval (CI) were calculated. Significance was determined using the Chi Square test or Fisher's exact test. For all comparisons, the significance level was considered as $p < 0.05$.

A backward logistic regression model was also developed to assess the association between the same clinical parameters and caries lesions activity in the first permanent molars. The significance level for entry into the model was specified at $p < 0.05$. For the included variables, OR and 95% CI were calculated. For these analyses, we only considered the values obtained in teeth with coincidence in the diagnosis obtained by visual inspection by the two examiners.

RESULTS

The intra-examiner reproducibility of the clinical parameters reached substantial or almost perfect agreement. The Cohen's kappa values ranged from 0.611 (presence of visible plaque on the occlusal surface of first permanent molars) to 0.917 (eruption degree of the first permanent molars) (Table 1). Regarding the visual inspection, the examiners achieved an inter-examiner reproducibility of 0.776 (substantial). When the visual score system was divided in sound teeth *vs.* carious teeth, the agreement was almost perfect (0.932). When the score system was separated in sound and inactive caries lesions *vs.* active caries lesions, the reliability value was 0.755 (substantial) (Table 1).

In the univariate analysis, significant association was observed between the presence of at least one active white spot in other tooth and the presence of active caries lesions on the occlusal surface of first permanent molars. The OR was 8.80 ($p < 0.001$) (Table 2). Abundant visible plaque on the occlusal surface of the first permanent molar was another clinical parameter significantly associated (OR = 3.54, $p < 0.05$) (Table 2). The remaining clinical parameters did not present significant association with active caries lesions in the first permanent molars (Table 2).

In the multivariate analysis, the results of backward elimination logistic regression presented two retained variables associated with active caries lesions in first permanent molars. The retained variables were presence of active white spots in other teeth (OR = 1.92; $p < 0.001$) and abundant

TABLE 1 - Reproducibility values of several clinical parameters.

Clinical parameters	Kappa values
Visual inspection: all separated scores	0.776
Visual inspection: sound teeth *vs.* presence of caries lesions	0.932
Visual inspection: sound teeth and teeth with inactive caries lesions *vs.* teeth with active lesions	0.755
General plaque index	0.800
Visible plaque on occlusal surface of 1st permanent molars	0.611
Eruption degree of 1st permanent molars	0.917
Active white spots caries lesions in other teeth	0.800
DMF-T and dmf-t	0.800

TABLE 2 - Results of univariate analysis of clinical parameters and association with the presence of active caries lesions on the occlusal surfaces of first permanent molars.

Clinical parameters		Sound teeth and inactive lesions n (%)	Active lesions n (%)	OR (95% CI)	p*
Gender	Female	55 (44.0)	7 (5.6)	1.00	
	Male	51 (40.8)	12 (9.6)	1.85 (0.61-5.69)	ns
Age	< 9 years old	59 (47.2)	11 (8.8)	1.00	
	≥ 9 years old	47 (37.6)	8 (6.4)	0.91 (0.30-2.70)	ns
DMF-T and dmf-t	< 3	45 (36.0)	6 (4.8)	1.00	
	≥ 3	61 (48.8)	13 (10.4)	1.60 (0.51-5.15)	ns
Presence of WS	Without WS	66 (52.8)	3 (2.4)	1.00	
	With WS	40 (32.0)	16 (12.8)	8.80 (2.21-40.74)	p < 0.001
General plaque index	< 1.8	41 (32.8)	9 (7.2)	1.00	
	≥ 1.8	65 (52.0)	10 (8.0)	0.70 (0.24-2.08)	ns
Dental arch	Upper	54 (43.2)	9 (7.2)	1.00	
	Lower	52 (41.6)	10 (8.0)	1.15 (0.39-3.40)	ns
Arch side	Right	57 (45.6)	8 (6.4)	1.00	
	Left	49 (39.2)	11 (8.8)	1.60 (0.54-4.79)	ns
Visible plaque on 1st molars	Slight plaque	91 (72.8)	12 (9.6)	1.00	
	Abundant plaque	15 (12.0)	7 (5.6)	3.54 (1.05-11.80)	p < 0.05
Eruption degree	Partial	44 (35.2)	9 (7.2)	1.00	
	Full	62 (49.6)	10 (8.0)	0.79 (0.27-2.33)	ns

OR = Odds Ratio. CI = confidence interval. *Significance evaluated by the Chi Square test or Fisher's exact test. ns = no statistically significant association (p > 0.05). WS = active white spots in other teeth.

TABLE 3 - Results of backward multivariate logistic regression analysis of several clinical parameters on the presence of active caries lesions assessed by visual inspection on occlusal surfaces of first permanent molars.

Clinical parameters	OR	95% CI	p
Presence of active white spots	1.92	1.36 – 2.72	0.0002
Abundant visible plaque	3.88	1.21 – 12.43	0.0228

Other variables did not retain in the model: age, gender, DMF-T and dmf-t, general plaque index, eruption degree of the 1st permanent molars, dental arch and tooth side. OR = Odds ratio. CI = confidence interval.

visible plaque accumulation on the occlusal surface of first permanent molars (OR = 3.88; p < 0.05) (Table 3). All the remaining clinical parameters were not retained in the regression model.

DISCUSSION

Evaluation of the caries lesions activity is more important than caries detection.[17] However, clinical examination of caries lesions activity is difficult because visual inspection is a subjective method, and an assessment of etiological factors could facilitate this evaluation. In the present study, the association between some clinical parameters and the presence of active caries lesions was investigated.

Caries lesions activity was evaluated by assessment of clinical characteristics of the lesions in a single examination. For this purpose, we used the diagnostic criteria system proposed by Nyvad *et al.*[20] (1999). This system has presented good inter- and intra-examiner agreement.[20] Moreover, despite the impossibility of an appropriate gold standard, this method presented construct and predictive validity.[19]

In order to minimize the subjectivity of clinical examination in the present study, training of the examiners was performed. The inter-examiner reproducibility of the visual inspection of the present study was substantial or almost perfect, and it was in agreement with that of a previous study.[20] Furthermore, only the coincident results of the two examiners were considered in the analyses. Nevertheless, the difficulty in evaluating the ac-

tual caries lesions activity was a limitation of the present study.

Concerning the association between clinical parameters and the presence of active caries lesions in the first permanent molars, there was no significant association between the presence of active caries lesions and the general plaque index in the present work. Studies involving the plaque index and caries lesions have presented controversial results.[1,15] It seems that dental caries prevention is more related to the widespread use of fluoride toothpastes than to plaque removal.[3]

On the other hand, there was a significant association between the presence of abundant visible plaque on the occlusal surfaces of first permanent molars and the presence of active caries lesions in these teeth. As the development of caries lesions occurs exactly under bacterial plaque,[11,21] the association between the presence of active caries lesions on the occlusal surfaces of first permanent molars and the presence of visible plaque on the same sites is more understandable than that with the general plaque index.

These facts are in agreement with the results of a previous study,[12] but they are in contrast to the results of another research.[9] These disagreements could be explained by the different statistical approaches used in those studies. In addition, the assessment of caries lesions activity was performed using a different diagnostic system in the latter study, mainly based on color changes of the arrested caries lesions,[9] although color evaluation must not be used as the single indicator of caries lesions activity.[18]

Some authors have asserted that the first permanent molars are more susceptible to develop caries lesions during the eruption period.[4,8,14] It was observed that partially erupted first permanent molars had more abundant visible plaque and a greater proportion of active caries lesions than fully erupted ones.[4] However, in the present study, there was no significant association between eruption degree of the first permanent molars and the presence of active caries lesions in these teeth. The presence of abundant visible plaque is probably more important in the development of dental caries than the eruption degree of the teeth. Thus, children with partially erupted molars could compensate this effect with efficient plaque removal. These facts could explain the significant association with visible plaque but not with eruption degree. In fact, careful plaque removal in partially erupted first permanent molars was able to arrest occlusal caries lesions.[5]

The presence of active caries lesions in first permanent molars and the presence of active white spots in other teeth were also associated. Otherwise, DMF-T and dmf-t did not show significant association. While activity reflects the dynamic nature of dental caries, DMF-T and dmf-t correspond to the past and present caries experience. Therefore, it is understandable that the presence of active caries lesions in other teeth is more related to the presence of active caries lesions in first permanent molars than the DMF-T and dmf-t. Several studies have shown that the past experience of dental caries is a significant factor of caries risk.[15] The majority of these studies, however, have considered cavitated caries lesions, independently of the activity of these lesions. In fact, in our present research, there was a significant association between dmf-t and DMF-T and the presence of caries lesions in the first permanent molars, independently of activity (OR = 2.09; 95% CI: 0.95-4.64; $p < 0.05$; unpublished data).

Evaluation of these clinical parameters could aid dentists to assess caries lesions activity in first permanent molars. However, the cross-sectional design used in this study has some limitations because there is no possibility to find a cause-effect relationship.[7] Thus, further longitudinal studies should be performed to corroborate the results of the present study.

CONCLUSION

The presence of active white spots in other teeth and the presence of abundant visible plaque were associated with the presence of active caries lesions on the occlusal surfaces of first permanent molars.

ACKNOWLEDGMENTS

The authors are very grateful to Dr. Paula Mochidome Yamaguti and Dr. Diego Machado Ardenghi for their English corrections.

REFERENCES

1. Andlaw RJ. Oral hygiene and dental caries – a review. Int Dent J. 1978;28(1):1-6.
2. Angmar-Mansson BE, al-Khateeb S, Tranaeus S. Caries diagnosis. J Dent Educ. 1998;62(10):771-80.
3. Bratthall D, Hansel-Petersson G, Sundberg H. Reasons for the caries decline: what do the experts believe? Eur J Oral Sci. 1996;104(4 Pt 2):416-22.
4. Carvalho JC, Ekstrand KR, Thylstrup A. Dental plaque and caries on occlusal surfaces of first permanent molars in relation to stage of eruption. J Dent Res. 1989;68(5):773-9.
5. Carvalho JC, Thylstrup A, Ekstrand KR. Results after 3 years of non-operative occlusal caries treatment of erupting permanent first molars. Community Dent Oral Epidemiol. 1992;20(4):187-92.
6. Cohen J. A coefficient agreement for nominal scales. Educ Psychol Meas. 1960;20:37-46.
7. Douglass CW. Risk assessment in dentistry. J Dent Educ. 1998;62(10):756-61.
8. Ekstrand KR, Christiansen J, Christiansen ME. Time and duration of eruption of first and second permanent molars: a longitudinal investigation. Community Dent Oral Epidemiol. 2003;31(5):344-50.
9. Ekstrand KR, Ricketts DNJ, Kidd EAM, Qvist V, Schou S. Detection, diagnosing, monitoring and logical treatment of occlusal caries in relation to lesion activity and severity: an *in vivo* examination with histological validation. Caries Res. 1998;32(4):247-54.
10. Ekstrand KR, Ricketts DNJ, Longbottom C, Pitts NG. Visual and tactile assessment of arrested initial enamel carious lesions: an *in vivo* pilot study. Caries Res. 2005;39(3):173-7.
11. Fejerskov O. Concepts of dental caries and their consequences for understanding the disease. Community Dent Oral Epidemiol. 1997;25(1):5-12.
12. Ferreira MA, Mendes NS. Factors associated with active white enamel lesions. Int J Paediatr Dent. 2005;15(5):327-34.
13. Greene JC, Vermillion JR. The simplified oral hygiene index. J Am Dent Assoc. 1964;68(1):7-13.
14. Helm S, Seidler B. Timing of permanent tooth emergence in Danish children. Community Dent Oral Epidemiol. 1974;2(3):122-9.
15. Kanellis MJ. Caries risk assessment and prevention: strategies for Head Start, Early Head Start, and WIC. J Public Health Dent. 2000;60(3):210-20.
16. Landis JR, Koch GG. An application of hierarchical kappa-type statistics in the assessment of majority agreement among multiple observers. Biometrics. 1977;33(2):363-74.
17. Nyvad B. Diagnosis *versus* detection of caries. Caries Res. 2004;38(3):192-8.
18. Nyvad B, Fejerskov O. Assessing the stage of caries lesion activity on the basis of clinical and microbiological examination. Community Dent Oral Epidemiol. 1997;25(1):69-75.
19. Nyvad B, Machiulskiene V, Baelum V. Construct and predictive validity of clinical caries diagnostic criteria assessing lesion activity. J Dent Res. 2003;82(2):117-22.
20. Nyvad B, Machiulskiene V, Baelum V. Reliability of a new caries diagnostic system differentiating between active and inactive caries lesions. Caries Res. 1999;33(4):252-60.
21. Zero DT. Dental caries process. Dent Clin North Am. 1999;43(4):635-64.

Received for publication on Mar 06, 2006
Sent for alterations on Jun 05, 2006
Accepted for publication on Jul 06, 2006