Brazilian Dental Science

unesp
UNIVERSIDADE ESTADUAL PAULISTA
"JÚLIO DE MESQUITA FILHO"
Instituto de Ciência e Tecnologia
Campus de São José dos Campos

ORIGINAL ARTICLE

DOI: https://doi.org/10.4322/bds.2022.e3125

Caries progression and need for reintervention on occlusal ICDAS 4 lesions after different treatments: a retrospective university-based study

Progressão de cárie e necessidade de reintervenção em lesões oclusais ICDAS 4 após diferentes tratamentos: um estudo retrospectivo de base universitária

Nadini Fraporti LUNKES[1], Maitê Munhoz SCHERER[2], Andressa da Silva ARDUIM[2], Patrícia Daniela Melchiors ANGST[2], Luciano CASAGRANDE[2], Jonas de Almeida RODRIGUES[2], Tathiane Larissa LENZI[2]

1 - Universidade Federal do Rio Grande do Sul, Department of Surgery and Orthopedics. Porto Alegre, RS, Brasil.
2 - Universidade Federal do Rio Grande do Sul, Post-Graduate Program in Dentistry. Porto Alegre, RS, Brasil.

ABSTRACT

Objective: To assess the caries progression and the need for reintervention on occlusal ICDAS 4 lesions after different treatments. **Material and Methods:** The sample consisted of records of children treated in a public setting who had at least an occlusal ICDAS 4 lesion in primary and/or permanent molars. The radiographic images of ICDAS 4 lesions at the first and last appointments were classified as absence of radiolucency, radiolucent image at the enamel–dentin junction, at the outer half or inner of the dentin. The need for retreatment after different treatments (non-invasive - topical fluoride applications, oral hygiene instructions and dietary guidance, micro-invasive - resin-based sealant, or invasive - restoration) was assessed by reviewing clinical and radiographic records. The need for retreatment was defined as any complication requiring mending (e.g., caries progression, total loss of sealant, or restoration failure). The Poisson regression model was used to investigate the association between individual and tooth-related variables and the outcome. **Results:** Among the 111 lesions in 81 patients, most (73.0%) lesions were in primary molars. Most lesions (52.3%) did not exhibit radiolucency, whereas 29.7% had radiolucency at the outer half of the dentin. The mean follow-up was 18.8 ± 6.5 months. After follow-up, 82.9% of the lesions did not require retreatment. The prevalence of ICDAS 4 lesions that did not need retreatment was higher among lesions with radiolucency at dentin (p=0.01). **Conclusion:** Most occlusal ICDAS 4 lesions did not require reintervention, especially those exhibiting radiolucency in the outer half of the dentin.

KEYWORDS

Dental caries; Clinical decision-making; Dental radiography.

RESUMO

Objetivo: Avaliar a progressão de cárie e a necessidade de reintervenção em lesões oclusais ICDAS 4 após diferentes tratamentos. **Material e Métodos:** A amostra consistiu de prontuários de crianças atendidas em ambiente público que apresentavam pelo menos uma lesão oclusal ICDAS 4 em molares decíduos e/ou permanentes. As imagens radiográficas de lesões ICDAS 4 na primeira e última consultas foram classificadas como ausência de radiolucidez, imagem radiolúcida na junção esmalte-dentina, em metade externa ou interna da dentina. A necessidade de retratamento após diferentes tratamentos (não invasivo – aplicações tópicas de flúor, orientações de higiene e dieta, micro-invasivo – selante resinoso ou invasivo – restauração) foi avaliada por meio da revisão dos registros clínicos e radiográficos. A necessidade de retratamento foi definida como qualquer complicação que requer intervenção (por exemplo, progressão da lesão, perda total do selante ou falha na restauração). O modelo de regressão de Poisson foi utilizado para investigar a associação entre as variáveis individuais e dentárias e o desfecho. **Resultados:** Entre as 111 lesões em 81 pacientes, a maioria (73,0%) das lesões eram em molares decíduos. A maioria das lesões (52,3%) não exibiu radiolucidez, enquanto que 29,7% apresentaram

radiolucidez em metade externa de dentina. O tempo de acompanhamento médio foi de 18,8 ± 6,5 meses. Após o acompanhamento, 82,9% das lesões não necessitaram de retratamento. A prevalência de lesões ICDAS 4 que não necessitaram de retratamento foi maior entre as lesões com radiolucidez em dentina (p=0,01). **Conclusão:** A maioria das lesões oclusais ICDAS 4 não requerem reintervenção, especialmente aquelas que exibem radiolucidez em metade externa da dentina.

PALAVRAS-CHAVE

Cárie dentária; Tomada de decisão clínica; Radiografia dentária.

INTRODUCTION

Despite the decline in the caries prevalence [1], occlusal surfaces are the sites most likely to have caries experience in children and adolescents [2,3]. In addition, it has been shown that underlying dentin shadows lesions present a higher risk of progression to dentin cavitation compared to sound surfaces or even initial carious lesions, mainly in occlusal surfaces of both primary and permanent teeth [2,3].

According to the International Caries Detection and Assessment System (ICDAS) [4], these lesions are defined as shadows of discolored dentin visible through the enamel surface, which may or may not show signs of localized enamel breakdown (loss of continuity of the surface that is not showing the dentin), and are classified as ICDAS 4 lesions. The shadow appearance is often seen more easily when the tooth is wet, and the darkened area shows an intrinsic shadow that may appear as grey, blue or brown in color [4].

In vitro studies [5,6] evaluating the relationship between the clinical and histological features of ICDAS 4 lesions have demonstrated a substantial involvement of dentin during histological analysis. On the other hand, in clinical studies [7,8], most ICDAS 4 lesions on the occlusal surfaces of permanent molars exhibited no radiolucency or radiolucency restricted to the enamel-dentin junction. Whereas the clinical-radiographic studies included large sample sizes, laboratory studies included a reduced number of ICDAS 4 lesions. Furthermore, extracted teeth may comprise a biased sample because they are possibly not representative of the ICDAS 4 lesions usually found in clinical practice. These findings highlight the necessity of radiographic examination to help in the decision-making process since it is the method of choice to assess caries depth [9]. Different treatments can be indicated according to the radiographic expression of such lesions. Primary teeth have thinner enamel and lower mineral content [10] than permanent teeth, and therefore, they have faster progression of the carious lesions [11]. However, no study has evaluated the radiographic pattern of ICDAS 4 lesions in primary molars.

The International Caries Classification and Management System (ICCMS) [12] integrates ICDAS scores with wider patient-level information for caries management, with non-cavitated carious lesions classified as initial stage decay and localized enamel breakdown and underlying dentin shadow lesions categorized as moderate stage decay. Although ICCMS was not yet validated for treatment purposes, this system recommends that active initial lesions should be managed with non-invasive or micro-invasive treatments, while micro-invasive or invasive treatments are suggested for active moderate lesions [12]. Nevertheless, it is known that the presence of mineral loss in dentin by itself does not indicate the need for operative treatment [5], and ICDAS 4 lesions with radiolucency up to the outer half of the dentin could also receive non-invasive approach [13,14]. To the best of our knowledge, no previous study has evaluated the impact of different approaches for treating ICDAS 4 lesions.

Therefore, this retrospective university-based study aimed to assess the caries progression and the need for reintervention on occlusal ICDAS 4 lesions of primary and permanent molars after different treatments.

MATERIAL AND METHODS

Ethical aspects

The local Research Ethics Committee approved the research protocol. The personal information of the patients was kept confidential.

This observational study conformed to the STROBE statement [15].

Study design, characteristics, and participants

This university-based retrospective study was conducted at Children and Youth Dental Clinic, School of Dentistry, Federal University of Rio Grande do Sul (UFRGS), Porto Alegre, Brazil. We retrospectively reviewed the clinical records (census) of all patients (aged 5-12 years) treated between 2015 and 2019 by fourth- and fifth-year undergraduate dental students under the supervision of experienced pediatric dental professors. Before providing dental treatment, the students were taught and trained to detect carious lesions based on the ICDAS. This activity consisted of conventional theoretical classes, practical activities with image projection and hands-on with extracted teeth. The bitewing radiographs were performed by trained students using film holders. Film processing was performed under standardized conditions and using fresh solutions. Clinical records of patients with at least an ICDAS 4 lesion on the occlusal surface of permanent or primary teeth were included in this study. Clinical records of patients with missing data on bitewing radiographic examination and those with obstructed radiographic visualization due to buccal/lingual/palatal restorations or orthodontic bands were excluded. Moreover, patients should have at least a second clinical and radiographic examination after treatment.

Different approaches could have been proposed to treat ICDAS 4 lesions according to the individual caries-risk and complementary radiographic evaluation: non-invasive (topical fluoride applications, oral hygiene instructions and dietary guidance), micro-invasive (resin-based sealant) or invasive (restorative treatment). Invasive treatment could be indicated for treating ICDAS 4 lesions exhibiting radiolucency at the outer or inner half of the dentin. Micro-invasive or non-invasive approaches could be recommended for lesions without radiolucency at the dentin, with radiolucent image at the enamel-dentin junction or at the outer half of the dentin. Dental treatment decisions were always supervised and authorized by the professors of the pediatric clinic.

Among the 1,464 clinical records, 242 patients had the presence of an ICDAS 4 lesion on the occlusal surface registered on their clinical records. Twenty-six records were excluded due to the lack of radiographic examination. Additionally, 135 records were excluded because they did not present clinical and/or radiographic examinations after treatment. Therefore, 81 clinical records of children were included in the study.

Data collection

Two researchers collected the following individual and clinical characteristics from clinical records: age, sex (boys or girls), dentition (primary or permanent), tooth type (first or second molars), arch (upper or lower), caries experience (decayed, missing, and filled teeth, *dmft*), treatment (non-invasive, micro-invasive, or invasive), visible biofilm at site (follow-up); clinical examination at the last appointment, and the total number of appointments.

One examiner was trained by a senior researcher to evaluate the radiographic images of ICDAS 4 lesions at the first appointment and after treatment. The following criteria were used: (0) absence of radiolucency, (1) radiolucent image at the enamel-dentin junction, (2) radiolucent image at the outer half of the dentin, and (3) radiolucent image at the inner half of the dentin [7]. Diagnostic reproducibility was determined by assessing 10% of the radiographs at two different moments (2-week interval). The Kappa coefficient for radiographic reproducibility evaluation was 0.91.

Outcome

We assessed clinically or radiographically determined need for retreatment. The need for retreatment was defined as any complication requiring mending (e.g., lesion progression, total loss of resin-based sealant, or restoration failure – repair, replacement, endodontic treatment or extraction) considering different treatment options. Clinical progression was considered when ICDAS 4 lesions at baseline progressed to ICDAS 5 or 6 carious lesions in the last appointment. Radiographic progression was defined when the radiographic evaluation changed to a higher score after the treatment.

Statistical analyses

Data analyses were performed using SPSS software (SPSS Inc., Chicago, IL, USA). Descriptive analysis provided a distribution summary based on the independent variables. The Poisson

Regression was used to investigate the association between independent variables and the outcome. Dependency of the variables for the same patient was considered (one patient could contribute to more than one tooth/lesion for the analysis). Thus, the regression models were conducted by means of Generalized estimating equations (GEE) on SPSS program, and took into account the patients as the unit of analysis and the tooth as the within-subject variable. For statistical purposes, we dichotomized the variables "treatment" (without mechanical locking [non-invasive treatment] or with mechanical locking [micro-invasive and invasive treatments]) and "radiographic image" (without radiolucent image at the dentin [absence of radiolucency] or with radiolucent image at dentin [radiolucent zone restricted to the enamel-dentin junction, with radiolucent image at the outer or the inner half of the dentin dentin]). The prevalence ratios (PRs) and their 95% confidence intervals (CIs) were obtained. A backward stepwise procedure was used to select covariates in the fitting model. Only variables with p-values <0.20 were included in the final model. The significance level was set at 5%.

RESULTS

The mean age of the children was 7.7 ± 2.0 years, and the mean *dmft* was 7.1 ± 3.2. In total, 81 patients (45 girls and 36 boys) with 111 underlying dentin shadow lesions (59 in girls and 52 in boys) were included in the analysis. The mean of ICDAS 4 lesions per child was 1.4 ± 0.6. The mean time between the first and last appointment was 18.8 ± 6.5 months.

The characteristics of the ICDAS 4 lesions according to the independent variables are presented in Table I. ICDAS 4 lesions were more common in primary teeth (73.0%) than in permanent teeth. Most lesions were located in the second molars (51.4%) and in the lower arch (56.8%). Furthermore, most lesions (52.3%) did not exhibit radiolucency; however, 29.7% exhibited radiolucency at the outer half of the dentin. Non-invasive treatment was scheduled in 62.2% of cases while 22.5% of the lesions received micro-invasive treatment. Invasive treatment was performed in 15.3% of cases. Moreover, visible biofilm was present in 58.6% of the lesions after follow-up.

Table II summarizes the relationship between radiographic aspects and clinical decision-making. Most underlying dentin shadow lesions that exhibited no radiolucency or radiolucency restricted to the enamel-dentin junction received non-invasive treatment, irrespective of the dentition (primary or permanent). The majority of the lesions with radiolucency at the outer half of the dentin in permanent molars (6/8) were restored, while an even distribution of micro-invasive and invasive approaches were observed in primary molars (micro-invasive 10/25, invasive 9/25). All lesions located at the inner half of the dentin received invasive treatment.

It was noted that 82.9% (n=92) of the lesions did not require retreatment. Of 58 ICDAS 4 lesions that exhibited no radiolucency at baseline, three lesions had progressed clinically (ICDAS score 5) and 15 lesions had progressed radiographically, with only two lesions located in permanent molars. All lesions that progressed clinically also had radiographic progression. In addition, one lesion in the primary molar restricted to the enamel-dentin junction at baseline showed clinical progression (ICDAS score 5). Three sealants performed in permanent molars were lost. In two cases, the sealant was placed over lesions exhibiting radiolucency restricted to the enamel-dentin junction and the other was performed over lesion with radiolucency at the outer half of the dentin. Thus, rates of need for reintervention and caries progression were 16.7% (5/30) and 6.7% (2/30)

Table I - The characteristics of the ICDAS 4 lesions according to the independent variables (n=111)

Variables		*N (%)*
Dentition	Primary	81 (73.0)
	Permanent	30 (27.0)
Tooth type	First molar	54 (48.6)
	Second molar	57 (51.4)
Arch	Upper	48 (43.2)
	Lower	63 (56.8)
Radiographic image	Absent	58 (52.3)
	Enamel-dentin junction	17 (15.3)
	Outer ½ dentin	33 (29.7)
	Inner ½ dentin	3 (2.7)
Treatment	Non-invasive	69 (62.2)
	Micro-invasive	25 (22.5)
	Invasive	17 (15.3)
Visible biofilm at site (follow-up)	Absent	46 (41.4)
	Present	65 (58.6)

Table II - Relationship between radiographic aspect and clinical decision-making.

Primary teeth (n=81)	Treatment							
Radiographic image	Non-invasive	Micro-invasive	Invasive	Total	Clinical progression	Radiographic progression	Sealant failure	Need for retreatment
Absent	37	4	0	41	3	13	0	13
Enamel-dentin junction	8	5	0	13	1	0	0	1
Outer ½ dentin	6	10	9	25	0	0	0	0
Inner ½ dentin	0	0	2	2	0	0	0	0
Permanent teeth (n=30)	Treatment							
Radiographic image	Non-invasive	Micro-invasive	Invasive	Total	Clinical progression	Radiographic progression	Sealant failure	Need for retreatment
Absent	15	2	0	17	0	2	0	2
Enamel-dentin junction	2	2	0	4	0	0	2	2
Outer ½ dentin	1	1	6	8	0	0	1	1
Inner ½ dentin	0	1	-	1	0	0	0	0

for permanent molars, respectively, while both rates were 15.3% (14/81) for primary molars.

Table III shows the unadjusted and adjusted PRs of the individual and tooth-related factors associated with the need for retreatment. In the unadjusted analysis, the presence of visible biofilm at site (follow-up) and radiographic image were associated with the outcome. The final adjusted model demonstrated that the prevalence of ICDAS 4 lesions that did not need retreatment was higher among lesions that exhibited radiolucency at dentin (PR: 0.12 95%CI: 0.02;0.59; p=0.01).

DISCUSSION

This is the first study to investigate the clinical and radiographic behavior of occlusal ICDAS 4 lesions after different therapies and factors associated with the need for retreatment. Of the 111 lesions included in our study, 81 were in primary molars and 30 were in permanent molars, which was expected since most permanent molars included in this study had recently erupted. The majority of the ICDAS 4 lesions exhibited no radiolucency (52.3%) whereas 29.7% presented radiolucency at the outer half of the dentin.

Previous studies [7,8] reported that most ICDAS 4 lesions in permanent molars exhibited no radiolucency or radiolucent zone restricted to the enamel-dentin junction. The frequency of lesions exhibiting radiolucency at the outer half of the dentin ranged from 0.7% [8] to 12.6% [7]. Furthermore, no association was found between enamel breakdown and radiographic features [7]. Since data were collected from clinical records, we could not differentiate shadow lesions with or without localized enamel breakdown. In our study, the higher frequency of ICDAS 4 lesions exhibiting radiolucency at the outer half of the dentin may be related to a higher number of primary molars in the sample as they have lower mineral content [10] and higher rate of caries progression than permanent molars [11].

We can note that the majority of the lesions (82.9%) did not need retreatment. The dentition was not associated with the outcome probably because very few events occurred in permanent molars. However, the prevalence of ICDAS 4 lesions that did not need retreatment was higher among lesions with radiolucency at dentin (PR: 0.12 95%CI: 0.02;0.59; p=0.01). The unadjusted analysis demonstrated that the presence of visible biofilm was associated to a higher prevalence of ICDAS 4 lesions that need for retreatment (PR 3.15 95%CI 1.02;10.22). However, this association was not significant in the adjusted analysis.

Most ICDAS 4 lesions that did not exhibit radiolucency or radiolucency restricted to the enamel-dentin junction received non-invasive treatment, irrespective of the dentition. However, these lesions were more likely to progress than locked mechanically lesions. It is known that biofilm control itself is an effective way to arrest carious lesions [16]. Non-invasive therapies might avoid or postpone invasive treatments, which could help retain teeth longer at lower costs [17].

Table III - Poisson regression analysis for need for retreatment of the ICDAS 4 lesions

Variables	N total/ N cases	Unadjusted PR (95% CI)	P-value	Adjusted PR (95% CI)	P-value
Sex					
Girls	45/9	1	0.59		
Boys	36/10	1.26 (0.54;2.93)			
Age	-	1.02 (0.85;1.21)	0.87		
dmft index	-	1.00 (0.91;1.11)	0.94		
Dentition					
Primary	81/14	1	0.94		
Permanent	30/mai	0.96 (0.36;2.59)			
Tooth type					
Second molar	57/11	1	0.41		
First molar	54/8	0.69 (0.29;1.66)			
Arch					
Upper	63/10	1	0.35		
Lower	48/9	0.69 (0.31;1.51)			
Radiographic image					
Without radiolucent image at dentin	75/18	1	0.03	1	0.01*
With radiolucent image at dentin		0.12 (0.02;0.78)		0.12 (0.02;0.59)	
	36/1				
Treatment					
Without mechanical locking (non-invasive)	69/15	1	0.2	1	0.99
With mechanical locking (micro- and invasive)					
	42/4	0.44 (0.13;1.53)		1.0 (0.36; 2.81)	
Visible biofilm at site (follow-up)					
Absent	46/4	1	0.04	1	0.06
Present	65/15	3.15 (1.02;10.22)		3.21 (0.94;10.88)	
Follow-up	-	1.01 (0.96;1.07)	0.62		

*Statistically significant

However, non-invasive treatments greatly depend on patient compliance. The scientific literature shows that non-invasively compared with micro-invasively treated occlusal carious lesions require more invasive retreaments over time [18]. In addition, non-invasive treatment seems to be more efficacious in enamel than dentinal lesions [18]. Our study included children with a high caries-risk and a low socioeconomic profile, representing the worst scenario for disease control exclusively through non-invasive approaches, mainly due to the difficulty of biofilm control over time. Visible biofilm was present in 58.6% of the lesions after follow-up.

In contrast, micro-invasive or invasive approaches were more frequently used for lesions radiographically located at the dentin (outer or inner half). Nonetheless, only three lesions were restricted to the inner half of the dentin. While resin-based sealants were placed over lesions without tissue removal, restorations were performed after selective carious tissue removal. Both strategies promoted mechanical locking of the ICDAS 4 lesions, avoiding clinical and radiographic progression. Only three sealants placed over the lesions in permanent molars were lost. This may be related to technical sensitivity to perform resin-based sealants, mainly when sealing partially erupted permanent teeth. However, there was no caries progression in none of these cases. It has been shown that the arrest of formerly sealed lesions might be maintained even after partial or total sealant loss. Lost sealants might therefore not always require resealing, which would decrease the need for retreatment after micro-invasive therapy [19].

This reinforces that sealing may be a good option for controlling noncavitated or minimally cavitated carious lesions reaching until outer half of the dentin. According to previous studies, resin-based sealants are effective in arresting occlusal dentinal carious lesions in primary [14] and permanent [20] teeth.

Sealants were preferable to treat lesions with radiolucency at the outer half of the dentin in primary teeth, whereas restoration was the most frequent treatment for lesions in permanent molars. Performing minimally invasive treatment as first-line therapy might require fewer retreatments, but due to the earlier ignition of the cycle of restorations, the first therapeutic option (minimally invasive treatment) is lost already, and more extended or expensive interventions might be required earlier. Patient age, tooth lifecycle, risk of painful sensitivity, possibility of patient monitoring, and recall intervals for check-ups are factors that might guide clinical decision-making.

One limitation of this study is its retrospective design, as the information was collected from patients' clinical records. However, dental students who filled out the files, performed the treatments, and followed up the patients were taught and supervised daily by senior professors of pediatric dentistry. Additionally, observational studies could demonstrate clinical reality, whereas uncontrolled settings may provide external validity. The findings of our study should be interpreted with caution since they cannot be extrapolated to children with a low caries-risk.

CONCLUSION

After 18 months of follow-up, this retrospective university-based study observed low and moderate rates of caries progression for permanent and primary molars with ICDAS 4 lesions, respectively, and similar rates of need for reintervention. The majority of the occlusal underlying dentin shadow lesions did not need retreatment, especially those exhibiting radiolucency at dentin. Randomized clinical trials may define the best treatment option for ICDAS 4 lesions in both types of dentition.

Acknowledgments

This study was financed in part by the Institutional Program of Scientific Initiation Grants of National Council for Scientific and Technological Development (PIBIC/CNPq).

Authors' Contributions

NFL: performed the methodology and wrote the manuscript. MMS: performed the methodology. ASA: contribution substantially to discussion, proofread the manuscript. PDMA: consulted on and performed statistical evaluation. LC: contribution substantially to discussion, proofread the manuscript. JAR: contribution substantially to discussion, proofread the manuscript. TLL: idea, proofread the manuscript.

Conflict of Interest

The authors have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

Funding

Institutional Program of Scientific Initiation Grants of National Council for Scientific and Technological Development (PIBIC/CNPq).

Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of the Federal University of Rio Grande do Sul. The approval number for this study is: CAAE: 20791119.7.0000.5347.

REFERENCES

1. Frencken JE, Sharma P, Stenhouse L, Green D, Laverty D, Dietrich T. Global epidemiology of dental caries and severe periodontitis: a comprehensive review. J Clin Periodontol. 2017;44(18, Suppl. 18):S94-105. PMid:28266116.
2. Guedes RS, Piovesan C, Floriano I, Emmanuelli B, Braga MM, Ekstrand KR, et al. Risk of initial and moderate caries lesions in primary teeth to progress to dentine cavitation: a 2-year cohort study. Int J Paediatr Dent. 2016;26(2):116-24. http://dx.doi.org/10.1111/ipd.12166. PMid:25923059.
3. Ferreira Zandoná A, Santiago E, Eckert GJ, Katz BP, Pereira de Oliveira S, Capin OR, et al. The natural history of dental caries lesions: a 4-year observational study. J Dent Res. 2012;91(9):841-6. http://dx.doi.org/10.1177/0022034512455030. PMid:22821238.
4. Pitts N. "ICDAS": an international system for caries detection and assessment being developed to facilitate caries epidemiology, research and appropriate clinical management. Community Dent Health. 2004;21(3):193-8. PMid:15470828.

5. Ekstrand KR, Martignon S, Ricketts DJN, Qvist V. Detection and activity assessment of primary coronal caries lesions: a methodologic study. Oper Dent. 2007;32(3):225-35. http://dx.doi.org/10.2341/06-63. PMid:17555173.

6. Diniz MB, Rodrigues JA, Hug I, Cordeiro RCL, Lussi A. Reproducibility and accuracy of the ICDAS-II for occlusal caries detection. Community Dent Oral Epidemiol. 2009;37(5):399-404. http://dx.doi.org/10.1111/j.1600-0528.2009.00487.x. PMid:19681984.

7. Bertella N, Moura DS, Alves LS, Damé-Teixeira N, Fontanella V, Maltz M. Clinical and radiographic diagnosis of underlying dark shadow from dentin (ICDAS 4) in permanent molars. Caries Res. 2013;47(5):429-32. http://dx.doi.org/10.1159/000350924. PMid:23712062.

8. Marquezan PK, Alves LS, Dalla Nora A, Maltz M, Zenkner JEA. Radiographic pattern of underlying dentin lesions (ICDAS 4) in permanent teeth. Clin Oral Investig. 2019;23(10):3879-83. http://dx.doi.org/10.1007/s00784-019-02818-y. PMid:30693398.

9. Bakhshandeh A, Ekstrand KR, Qvist V. Measurement of histological and radiographic depth and width of occlusal caries lesions: a methodological study. Caries Res. 2011;45(6):547-55. http://dx.doi.org/10.1159/000331212. PMid:22024919.

10. Mortimer KV. The relationship of deciduous enamel structure to dental disease. Caries Res. 1970;4(3):206-23. http://dx.doi.org/10.1159/000259643. PMid:5270190.

11. Sønju Clasen AB, Ogaard B, Duschner H, Ruben J, Arends J, Sönju T. Caries development in fluoridated and non-fluoridated deciduous and permanent enamel in situ examined by microradiography and confocal laser scanning microscopy. Adv Dent Res. 1997;11(4):442-7. http://dx.doi.org/10.1177/08959374970110041001. PMid:9470502.

12. Pitts NB, Ekstrand KR. International Caries Detection and Assessment System (ICDAS) and its International Caries Classification and Management System (ICCMS) - methods for staging of the caries process and enabling dentists to manage caries. Community Dent Oral Epidemiol. 2013;41(1):e41-52. http://dx.doi.org/10.1111/cdoe.12025. PMid:24916677.

13. Borges B, Campos GBP, da Silveira ADS, de Lima KC, Pinheiro I. Efficacy of a pit and fissure sealant in arresting dentin non-cavitated caries: a 1-year follow-up, randomized, single-blind, controlled clinical trial. Am J Dent. 2010;23(6):311-6. PMid:21344828.

14. Borges BCD, de Souza Borges J, Braz R, Montes MAJR, de Assunção Pinheiro IV. Arrest of non-cavitated dentinal occlusal caries by sealing pits and fissures: a 36-month, randomised controlled clinical trial. Int Dent J. 2012;62(5):251-5. http://dx.doi.org/10.1111/j.1875-595X.2012.00117.x. PMid:23106838.

15. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, Strobe Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370(9596):1453-7. doi: 10.1016/S0140-6736(07)61602-X.

16. Paes Leme AF, Dalcico R, Tabchoury CPM, Del Bel Cury AA, Rosalen PL, Cury JA. In situ effect of frequent sucrose exposure on enamel demineralization and on plaque composition after APF application and F dentifrice use. J Dent Res. 2004;83(1):71-5. http://dx.doi.org/10.1177/154405910408300114. PMid:14691117.

17. Schwendicke F, Meyer-Lueckel H, Stolpe M, Dörfer CE, Paris S. Costs and effectiveness of treatment alternatives for proximal caries lesions. PLoS One. 2014;9(1):1-10. http://dx.doi.org/10.1371/journal.pone.0086992.

18. Schwendicke F, Jäger AM, Paris S, Hsu LY, Tu YK. Treating pit-and-fissure caries: a systematic review and network meta-analysis. J Dent Res. 2015;94(4):522-33. http://dx.doi.org/10.1177/0022034515571184. PMid:25710951.

19. Mickenautsch S, Yengopal V. Validity of sealant retention as surrogate for caries prevention--a systematic review. PLoS One. 2013;8(10):e77103. http://dx.doi.org/10.1371/journal.pone.0077103. PMid:24194861.

20. Bakhshandeh A, Qvist V, Ekstrand KR. Sealing occlusal caries lesions in adults referred for restorative treatment: 2-3 years of follow-up. Clin Oral Investig. 2012;16(2):521-9. http://dx.doi.org/10.1007/s00784-011-0549-4. PMid:21479565.

Tathiane Larissa Lenzi
(Corresponding address)
Universidade Federal do Rio Grande do Sul, Post-Graduate Program in Dentistry, Porto Alegre, RS, Brasil.
Email: tathiane.lenzi@ufrgs.br

Date submitted: 2021 June 24
Accept submission: 2021 Nov 30