UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL

FACULDADE DE ODONTOLOGIA

PROGRAMA DE PÓS-GRADUAÇÃO EM ODONTOLOGIA

Linha de Pesquisa:

Biomateriais e Técnicas Terapêuticas em Odontologia

LESÕES CARIOSAS OCLUSAIS

EM MOLARES PERMANENTES

Tese apresentada ao Programa de Pós-Graduação em Odontologia como parte dos requisitos obrigatórios para a obtenção do título de Doutor em Clínica Odontológica com ênfase em Cariologia/Dentística

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Porto Alegre, dezembro de 2013

CIP - Catalogação na Publicação

Zenkner, Júlio Eduardo do Amaral
Lesões cariosas oclusais em molares permanentes / Júlio Eduardo do Amaral Zenkner. -- 2013.
77 f.

Orientador: Marisa Maltz.

Tese (Doutorado) -- Universidade Federal do Rio Grande do Sul, Faculdade de Odontologia, Programa de Pós-Graduação em Odontologia, Porto Alegre, BR-RS, 2013.

1. Cárie dentária. 2. Diagnóstico. 3. Biofilme bacteriano. 4. Erupção dentária. 5. Lesões inativas. I. Maltz, Marisa, orient. II. Título.

Elaborada pelo Sistema de Geração Automática de Ficha Catalográfica da UFRGS com os dados fornecidos pelo(a) autor(a).

“Não tendes o direito de esquivar um esforço,

a não ser em nome de outro esfôrço,

porque é vossa obrigação crescer.”

Antoine de Saint-Exupéry em CIDADELA

DEDICATÓRIA

À minha Orientadora na Pós-graduação e na vida Profissional, Professora Doutora *Marisa Maltz*, dedico este Doutorado.

Ao Comendador da Cruz Missioneira, *Apparício Sebastião do Amaral*, sábio autodidata e exemplo maiúsculo de cidadão ideal, dedico este título.

A meus *pais Maria Apparecida do Amaral Zenkner* e *Júlio Erni Zenkner* e a meus *irmãos Luiz Fernando, Paulo Rogério, Maria Angélica* e *José Rafael*, por estarem sempre perto, apontando o caminho mais correto; À minha esposa *Clacir Londero Zenkner* e ao nosso filho *Germano Londero Zenkner*, por terem passado por tudo ao meu lado, enquanto aprendíamos juntos a viver, dedico esta conquista.

AGRADECIMENTOS

À Professora Doutora *Marisa Maltz*, minha Professora, Orientadora e Amiga, agradeço por ter iluminado minha carreira docente com seu conhecimento, exemplo de conduta e disponibilidade e por ter tornado possível a realização deste doutorado.

À Professora Doutora *Joana Christina de Carvalho*, minha Orientadora no Programa de Doutorado Sanduíche no Exterior, pela acolhida e pelos importantes ensinamentos.

A meu Amigo e Irmão *Mario Bernardes Wagner*, pelas longas horas de trabalho e pelos inumeráveis ensinamentos. A vida é bela também pela filosofia que enseja!

A meu Professor e Amigo *Fernando Borba de Araújo*, pelos ensinamentos inestimáveis, pelo exemplo de verdadeiro amor à profissão e à ciência e por sua confiança em meu trabalho em qualquer circunstância.

A meu Orientador de Mestrado, Professor Doutor *Luiz Narciso Baratieri*, pelos ensinamentos e pela autoconfiança que me inspirou a ter.

Aos Professores *Clarissa Fatturi Parolo, Juliana Jobim Jardim, Berenice Barbachan e Silva*, *Lina Naomi Hashizume, Sandra Liana Henz,* e *Rodrigo Arthur* pela amizade, exemplos e companheirismo.

A meus Amigos e Colegas de doutorado *Luana Severo Alves, Maurício Moura* e *Nailê Damé Teixeira*, pelo companheirismo, desprendimento e inestimável ajuda.

A meus Amigos e Irmãos *Carlos Heitor da Cunha Moreira, José Mariano da Rocha, Luciano Casagrande, Thiago Machado Ardenghi* e *Tiago Fiorini* pela Amizade indestrutível e sem limites.

A meus Amigos *Luis Felipe Valandro* e *Karla Kantorski* pela amizade fiel e pela confiança de que poderemos produzir ciência juntos.

A meus Amigos e Irmãos *Marcus Vinicius Fioravanti Vaucher* e *Rainer Scheinpflug* pela Amizade indestrutível e sem limites e por me deixarem claro que não existem momentos comuns, tudo dá certo no final.

A meus Amigos e Irmãos *Elma Trevisan* e *José Américo de Mello* pela Amizade indestrutível e sem limites e por me mostrarem beleza no raciocínio científico.

À minha Amiga e Irmã *Andréa Proença Flores*, presença constante, pelo estímulo e disponibilidade em auxiliar sempre nos exames das crianças envolvidas no trabalho e pelas lições de otimismo e paciência.

A meu Amigo *Jonas Almeida Rodrigues*, pelo companheirismo e pela dedicada partilha da ciência da nossa profissão.

A meu Amigo *Saul Martins de Paiva*, pelo companheirismo de muitos anos e pelo apoio durante o doutorado.

A meus Colegas e Amigos *Adriela Mariath*, *Alex Haas* e *Juliano Cavagni*, pela boa parceria.

A meu Amigo e companheiro de pensamento científico *Jessye Giordani*, pela amizade confiante e disponibilidade em colaborar sempre.

A meus colegas de Disciplina e Amigos *Renan Rademacher*, *Ubiratan Tupinambá da Costa* e *Tathiane Larissa Lenzi* pela Amizade e apoio.

Ao Diretor do Centro de Ciências da Saúde da UFSM, meu Amigo e Irmão *Paulo Affonso Burmann*, pelo incentivo e apoio durante este projeto.

Ao Chefe do Departamento de Estomatologia, meu Amigo e Irmão *Walter Blaya Perez*, pela confiança e pelo apoio incansável.

Às colegas e amigas *Renata Schlesner de Oliveira, Raquel Hecker Bica* e *Ângela Dalla Nora*, companheiras na conquista do conhecimento, pela inestimável ajuda e confiança de que daria tudo certo.

A todos os *escolares* examinados, seus pais e responsáveis, pela disposição em colaborar e pela valorização da saúde conquistada.

Ao *Programa de Pós-Graduação em Odontologia* da *Universidade Federal do Rio Grande do Sul*, em especial ao Professor Doutor *Manoel Sant'Ana Filho* e à *Adriana Aguiar*, pela acolhida e por terem tornado possível a realização deste doutorado.

À *Colgate-Palmolive*, pela doação das escovas e cremes dentais.

À *CAPES*, pela concessão da bolsa de doutorado Sanduíche no Exterior.

SUMÁRIO

RESUMO

Objetivos: O objetivo geral desta tese foi estudar o comportamento clínico da cárie dentária em superfícies oclusais de molares permanentes. Ela é composta por três estudos cujos objetivos específicos foram: (1) Avaliar a acurácia e reprodutibilidade de um índice visual para o registro do acúmulo de biofilme em superfícies oclusais; (2) Avaliar o efeito independente do acúmulo de biofilme e do estágio eruptivo na atividade de cárie em superfícies oclusais de molares permanentes; e (3) Comparar as taxas de incidência/progressão de cárie em superfícies oclusais hígidas e lesões cariosas inativas bem como avaliar o risco de progressão de cárie nestas superfícies. **Metodologia**: Avaliou-se visualmente o acúmulo de biofilme nas superfícies oclusais de 80 molares permanentes de acordo com os escores a seguir: 0 = sem biofilme visível; 1 = biofilme dificilmente detectável nas fossas e fissuras; 2 = biofilme facilmente detectável nas fossas e fissuras; 3 = superfície oclusal parcialmente ou totalmente coberta por biofilme espesso. As avaliações clínicas foram executadas três vezes, sem uso de evidenciador no primeiro e no segundo exames e usando fucsina a 7% na terceira observação. Reprodutibilidade intra-examinador, sensibilidade, especificidade, valores preditivos positivo e negativo e acurácia foram calculados, utilizando o exame com fucsina como o padrão ouro. Estas medidas diagnósticas foram calculadas para cada escore do índice original e para o índice dicotomizado de acordo com a presença de biofilme espesso (0 + 1 versus 2 + 3). Na linha de base, 298 escolares entre 6 e 15 anos tiveram seus molares permanentes examinados com relação ao estágio de erupção (1 = superfície oclusal parcialmente erupcionada; 2 = superfície oclusal totalmente erupcionada e mais da metade da superfície vestibular coberta por tecido gengival; 3 = superfície oclusal totalmente erupcionada e menos da metade da superfície vestibular coberta por tecido gengival; 4 = dente em oclusão funcional), acúmulo e localização de biofilme, conforme o critério descrito anteriormente e presença e localização de lesões cariosas ativas nas superfícies oclusais. Para ser incluído no estudo longitudinal, os escolares deveriam ser classificados como cárie-inativos e apresentar pelo menos um molar permanente hígido e um molar permanente com lesão cariosa inativa (n=258). Após 12 meses, novo exame clínico foi realizado conforme o exame inicial (estágio de erupção, acúmulo de biofilme, presença de cárie ativa). Em ambos os exames, a exata localização das lesões cariosas foram registradas em esquemas das superfícies oclusais a fim de garantir o monitoramento da mesma lesão ao longo do tempo. A análise estatística utilizou equações de estimativas generalizadas com ligação logística tendo em vista a presença de dados aglomerados. Odds ratio (OR) e seus respectivos intervalos de confiança de 95% (IC 95%) foram estimados. As taxas de incidência/progressão de cárie em superfícies oclusais hígidas e lesões cariosas inativas foram comparadas através do teste do qui-quadrado. **Resultados**: As análises repetidas demonstraram que o índice avaliado é reprodutível (k=0.8). A dicotomização a partir da presença ou ausência de biofilme espesso obteve sensibilidade, especificidade, acurácia e valores preditivos positivo e negativo ≥ 0.95. Foi observada uma associação significativa entre atividade de cárie e estágio eruptivo de molares permanentes. Ajustado para o acúmulo de biofilme, os molares em erupção apresentaram um risco de apresentar lesões cariosas ativas significativamente maior do que os molares em oclusão funcional (estágio eruptivo 1, OR=63,3, IC 95%=22-183,7; estágio eruptivo eruptivo 2, OR=14,9, IC 95%=7,1-31,2;

estágio eruptivo 3, OR=4,1, IC 95%=2-8,4). Ajustado para o estágio eruptivo, os dentes com biofilme facilmente detectável foram mais suscetíveis à atividade de cárie do que os dentes sem biofilme visível (grau 2, OR=5,5, IC 95%=2,5-12,3; grau 3, OR=14,5, IC 95%=6,5-32,4). No estudo longitudinal, 200 escolares foram reexaminados após 12 meses (taxa de perda de 22,5%). Foram encontradas pequenas taxas de progressão das lesões cariosas inativas (3,9%) e incidência nas superfícies hígidas (2,6%) ao longo de 12 meses, não tendo sido encontrada diferença entre os grupos (qui-quadrado, p=0,48). Ajustado para o acúmulo de biofilme, estágio eruptivo, tipo de molar e arco, as lesões cariosas inativas apresentaram um risco à progressão similar às superfícies oclusais hígidas (OR=0,98, IC 95%=0,40-2,38). A presença de biofilme facilmente detectável (graus 2 + 3) na superfície oclusal foi o único preditor da incidência e progressão de cárie após 1 ano (OR=2,73, IC 95%=1,01-7,41). **Conclusões**: Acúmulos de biofilme em superfícies oclusais de molares permanentes podem ser visualmente avaliados de modo acurado e reprodutível. O uso de um corante evidenciador pode não ser necessário. O período de erupção dos molares permanentes pode ser visto como um período de risco para o desenvolvimento de lesões cariosas ativas em crianças e adolescentes. Superfícies oclusais com lesões cariosas inativas não requerem atenção adicional àquela normalmente dispensada às superfícies oclusais hígidas em um período de 12 meses.

PALAVRAS-CHAVE

Cárie dentária, superfícies oclusais, molares permanentes, estágio de erupção, lesões cariosas inativas, estudo clínico.

ABSTRACT

Objectives: The general aim of this thesis was to study the clinical behavior of dental caries on the occlusal surfaces of permanent molars. It is composed by three studies whose specific aims were: (1) To assess the accuracy and reproducibility of a simplified, visual index to assess biofilm accumulation on occlusal surfaces ; (2) To estimate the independent effects of biofilm accumulation and eruption stage on the occurrence of active caries lesions on occlusal surfaces of permanent molars; and (3) To compare caries incidence and progression on sound occlusal surfaces and on surfaces presenting inactive enamel lesions as well as to estimate the risk of caries progression on these surfaces. **Methods**: Biofilm accumulation on occlusal surfaces of 80 permanent molars was visually assessed and scored as follows: (0) no visible biofilm; (1) hardly detectable biofilm, restricted to grooves and fossae; (2) biofilm easily detectable in grooves and fossae; and (3) occlusal surface partially or totally covered with heavy biofilm accumulations. Clinical examinations were performed three times, using no detector dye in the first and second examinations, and using 7% fuchsine in the third examination. Intra-examiner reproducibility, sensitivity, specificity, positive and negative predictive values, and accuracy were calculating using the examination with fuchsine as the gold standard. These diagnostic measures were calculated for each biofilm score and for the dichotomized index according to the presence of thick biofilm (0 + 1 versus 2 + 3). At baseline, 298 6-15-year-old schoolchildren had their permanent molars examined in regards to stage of eruption (1 = the occlusal surface partially erupted; 2 = the occlusal surface fully erupted, but more than half of the tooth facial surface was covered with gingival tissue; 3 = the occlusal surface fully erupted, and less than half of the tooth facial surface was covered with gingival tissue; 4 = full occlusion), occurrence and localization of occlusal plaque as previously described, and occurrence and localization of occlusal caries. To be included in the study, children should present a status of caries-inactive dentition with at least one permanent molar with sound occlusal surface and another permanent molar with inactive occlusal enamel lesion (n=258). After 12 months, clinical examination was repeated according to the baseline examination (stage of eruption, plaque accumulation, and active occlusal caries). In both examinations, the exact localization of occlusal caries was detailed mapped on standardized drawings of the occlusal groove-fossa-system in order to assure that the same lesion would be monitored over time. Statistical analysis was performed using generalized estimating equations with a logistic link function due to the clustering of data. Odds ratio (OR) and their respective 95% confidence intervals (95% CI) were estimated. The proportion of new caries lesions or lesions that progressed on sound occlusal sites and on sites presenting inactive enamel lesions was compared using the Chi-square test. **Results**: Repeated analysis showed that the index under study is reproducible (k=0.8). It was observed a significant association between stage of eruption and active caries on permanent molars. Adjusted for biofilm accumulation, molars under eruption were at an increased risk for active caries than molars in full occlusion (stage of eruption 1, OR=63.3, IC 95%=22-183.7; stage of eruption 2, OR=14.9, IC 95%=7.1-31.2; stage of eruption 3, OR=4.1, IC 95%=2-8.4). Adjusted for stage of eruption, teeth with easily detectable biofilm were more susceptible to caries activity than those without visible biofilm accumulation (score 2, OR=5.5, 95% CI=2.5-12.3; score 3, OR=14.5, 95% CI=6.5-32.4). At the longitudinal study, 200 schoolchildren were followed (dropout rate of

22.5%). It was observed low rates of lesion progression in inactive enamel lesions (3.9%) and sound surfaces (2.6%), with no difference between them (chi-square test, p=0.48). Adjusted for plaque, stage of eruption, type of molar and dental arch, inactive enamel lesions presented a similar risk for caries progression than sound occlusal surfaces (OR=0.98, 95%CI=0.40-2.38). The presence of easily detectable plaque (scores 2 + 3) on occlusal sites was the only predictor for caries incidence and progression after 1 year (OR=2.73: 95% CI 1.01-7.41). **Conclusions**: Biofilm accumulation on occlusal surfaces of permanent molars can be visually assessed in an accurate and reproducible way. The use of a detector dye may not be necessary. The stage of eruption of permanent molars can be regarded as a risk period for active caries in children and adolescents. Occlusal surfaces harboring inactive caries lesions do not require additional attention than the one normally given to sound occlusal surfaces over a 12-months period.

KEYWORDS

Dental caries, occlusal surfaces, permanent molars, dental eruption, inactive enamel lesions, clinical study.

Perfil da doença cárie

O perfil da cárie como doença tem-se alterado significativamente nas últimas décadas. A evidente redução na incidência e na velocidade de progressão das lesões ativas rumo à cavitação (PITTS; LONGOBOTTOM, 1995; KRASSE, 1996; BARMES, 1999; BAELUM; HEIDMANN; NYVAD, 2006) ensejam um aprimoramento nos processos de diagnóstico e tratamento da cárie dentária.

A baixa prevalência e incidência de cárie experimentada no mundo nas últimas décadas, a qual é atribuída basicamente ao uso de fluoretos (NYVAD, 2005), é em grande parte reflexo da redução da velocidade de progressão das lesões (PITTS; LONGOBOTTOM, 1995; KRASSE, 1996; BARMES, 1999; BAELUM; HEIDMANN; NYVAD, 2006), com longos períodos de tempo entre a detecção clínica da lesão restrita ao esmalte até o estágio de cavitação. Como consequência, pesquisas epidemiológicas conduzidas na década de 1990 já revelavam que lesões não cavitadas eram mais prevalentes do que lesões cavitadas (ISMAIL, 1997; AMARANTE; RAADAL; ESPELID, 1998; BISCARO *et al*., 2000). Em um estudo de prevalência, AMARANTE e colaboradores (1998) detectaram que as lesões não cavitadas representavam uma parcela crescente do total de lesões cariosas diagnosticadas entre os 5 e os 18 anos de idade. PITTS e FYFFE (1988) em um estudo clínico de diagnóstico de cárie observaram que quando a detecção de lesões não cavitadas em esmalte foi incluída, os índices CPO-D e CPO-S duplicaram, enquanto o número de pacientes considerados “livres de cárie” decresceu à quarta parte do anteriormente observado.

Estudos relataram que os levantamentos epidemiológicos clássicos, nos quais a detecção de lesões não cavitadas não é incluída nos critérios de diagnóstico, subestimam a experiência de cárie e superestimam o número de indivíduos “livres de cárie” (AMARANTE; RAADAL; ESPELID, 1998; PITTS, 1997; ASSAF *et al*., 2004). No momento em que as lesões não cavitadas deixam de ser detectadas, um indivíduo portador apenas deste tipo de lesão pode ser considerado “livre de cárie”, o que impede uma abordagem da doença em sua fase precoce e reversível. Ademais, os esforços terapêuticos tendem a se direcionados apenas para as cavidades e para a reposição dos tecidos dentários perdidos, o que reconhecidamente não é capaz de melhorar as condições de saúde bucal ao longo da vida (ELDERTON, 2003). As lesões não cavitadas podem, em alguns casos, constituir-se nos únicos sinais clínicos indicativos da presença de doença – o que é especialmente importante em populações com baixa prevalência de cárie. A inclusão das lesões cariosas não cavitadas nos levantamentos permite uma visão mais realista da experiência total de cárie dos indivíduos e populações (PITTS, 2008).

Diagnóstico da cárie dentária

As lesões não cavitadas de cárie geralmente são detectáveis mediante um exame clínico criterioso (PITTS, 1997). Assim, a remoção do biofilme previamente ao exame visual dos dentes é um procedimento imprescindível para uma abordagem conservadora da doença. Somente através de um exame clínico bem conduzido e de uma inspeção visual minuciosa e criteriosa, estando as superfícies dentárias adequadamente limpas, secas e bem iluminadas, é possível realizar um diagnóstico preciso de lesões não cavitadas em esmalte (ASSAF *et al*., 2004; ISMAIL, 2004).

Além da necessidade de se detectar clinicamente lesões não cavitadas em esmalte, têm-se evidenciado a preocupação em estabelecer critérios para a classificação das lesões quanto a sua atividade.

As modificações teciduais que ocorrem durante o processo dinâmico da cárie dentária, na sua formação e paralisação, foram demonstradas em uma série de estudos (HOLMEN *et al*., 1985a; HOLMEN *et al*., 1985b; HOLMEN; THYLSTRUP; ARTUN, 1987). Lesões cariosas não cavitadas foram criadas experimentalmente *in vivo* em pré-molares indicados à extração mediante a proteção de uma porção do esmalte dentário por uma banda ortodôntica. Utilizando-se de microscopia de luz polarizada, os autores evidenciaram a definição das 4 camadas típicas da lesão cariosa não cavitada após um período de 4 semanas de acúmulo de biofilme: camada superficial, corpo da lesão, zona escura e zona translúcida (HOLMEN *et al*., 1985a). Foi observado também um significativo aumento na porosidade do esmalte. Após o mesmo período de tempo, utilizando-se de microscopia eletrônica de varredura, os autores detectaram a destruição dos cristais do esmalte interprismático e inclusive de alguns prismas do esmalte (HOLMEN *et al*., 1985b). Ao serem novamente expostas ao ambiente bucal por 3 semanas, as lesões cariosas mostraram sinais de inativação, evidenciando recuperação do brilho e da dureza, além de um rápido e gradual desgaste da superfície erodida (HOLMEN; THYLSTRUP; ARTUN, 1987).

A transição da condição de atividade para inatividade envolve alterações características da superfície dentária, o que pode ser atribuído para lesões em esmalte e em dentina, em superfícies coronárias ou radiculares. Estas observações corroboram o conceito dinâmico de progressão da lesão cariosa e enfatizam a relevância de classificar clinicamente as lesões quanto a sua atividade.

O critério tradicionalmente utilizado para a classificação das lesões cariosas quanto à sua atividade baseia-se na avaliação das características clínicas da lesão, basicamente coloração e textura/dureza. As lesões cariosas são normalmente classificadas em: 1) lesão não cavitada ativa = esmalte opaco com superfície esbranquiçada e rugosa; 2) lesão não cavitada inativa = superfície com aparência brilhante, lisa, branca ou com diferentes graus de coloração acastanhada; 3) lesão cavitada ativa = destruição localizada da superfície com esmalte opaco-esbranquiçado e dentina amolecida e de coloração normalmente marrom claro; 4) lesão cavitada inativa = destruição localizada com superfície duras, brilhante, com coloração em diferentes graus de acastanhado (MALTZ *et al*., 2003).

Apesar da inclusão de lesões não cavitadas em estudos clínicos e epidemiológicos ter ocorrido de maneira mais sistemática a partir da década de 80, estudos anteriores já utilizavam este critério de diagnóstico. Ainda na década de 50, o clássico estudo de Vipeholm relatou o registro das lesões cariosas não cavitadas com "coloração branco-giz" (GUSTAFSSON *et al*., 1954). Desde então, diversos estudos têm realizado o registro das lesões não cavitadas ativas baseados no entendimento de que tais lesões estão em progressão e necessitam de tratamento (ZICKERT; LINDVALL; AXELSSON, 1982; BARBACHAN e SILVA; MALTZ, 2001; MALTZ; SCHOENARDIE; CARVALHO, 2001).

Nos anos 2000, um grupo de pesquisadores sugeriu um novo índice para a detecção e abordagem da cárie, o qual contempla o registro de lesões cariosas em todos os estágios nos quais a doença é clinicamente detectável. O *International Caries Detection and Assessment System (*ICDAS) teve como objetivo principal desenvolver uma padronização mundial para a identificação e o registro do acometimento pela doença, visando atuação em âmbito clínico, epidemiológico e de pesquisa (ISMAIL *et al*., 2007). O ICDAS classifica as lesões cariosas em seis estágios de severidade, desde lesões não cavitadas visíveis apenas após secagem até amplas lesões dentinárias com destruição coronária. Este índice não diferencia a atividade das lesões, incluindo tanto lesões ativas como inativas. O método tem se mostrado reprodutível e acurado. EKSTRAND e colaboradores (2007) estudaram a acurácia do sistema ICDAS no registro do diagnóstico de lesões cariosas oclusais em dentes permanentes extraídos. Os resultados encontrados permitiram considerar o sistema válido para detectar lesões e predizer sua profundidade, comparando-o com os resultados de uma avaliação histológica.

A publicação do ICDAS levantou a questão acerca da importância de diagnosticar as lesões cariosas inativas em estudos epidemiológicos. O registro destas lesões aumenta drasticamente a experiência de cárie das populações, atingindo taxas de prevalência superiores a 75% aos 12 anos de idade (AGUSTSDOTTIR *et al*., 2010; ALVES, 2012) e não fornece informações sobre a necessidade de tratamento.

No mesmo estudo citado anteriormente (EKSTRAND *et al*., 2007), os autores também consideraram aceitável a acurácia de um sistema de determinação da atividade ou inatividade de lesões cariosas por meio de indicadores clínicos, o *Lesion Activity Assesment* (LAA). De acordo com este critério, escores numéricos são atribuídos a três características, a saber: aspecto quanto ao critério ICDAS, localização em áreas com ou sem potencial para acúmulo de biofilme dentário e rugosidade ou lisura ao tato com um instrumento. A lesão é classificada em ativa quanto a somatória dos escores atingir um valor igual ou maior a 7. Embora este método possa ser mais objetivo que o critério padrão, ele parece superestimar a atividade das lesões quando comparado aos métodos tradicionais (BRAGA *et al*. 2010; OLIVEIRA *et al*., 2013). De acordo com o LAA, toda a lesão cariosa localizada em área predisposta ao acúmulo de biofilme (valor atribuído pelo critério = 4) e que apresentar superfície rugosa (valor = 3) atingirá o ponto de corte, sendo, assim classificada como ativa.

Tratamento não invasivo da doença cárie

A detecção cada vez mais precoce das lesões cariosas visa possibilitar o tratamento em seus estágios iniciais e, em última instância, à preservação das estruturas dentárias. Propostas de tratamento não invasivo têm sido sugeridas dentro de um contexto de promoção de saúde, a fim de controlar a doença e, consequentemente, a progressão da lesão. Este controle consiste em controlar o acúmulo de biofilme, adequação da dieta, uso adequado dos fluoretos e abordagem da saliva deficiente. Entre o início da década de 90 e o início dos anos 2000 foram publicados resultados de programas de tratamento voltado ao controle de lesões oclusais baseados na educação para a saúde e higiene profissional de acordo com a necessidade individual de cada paciente. Foi observado um significativo decréscimo do número de superfícies com placa visível e o aumento da proporção de lesões inativas, comparativamente às lesões ativas (CARVALHO; EKSTRAND; THYLSTRUP, 1989). Após um (CARVALHO; EKSTRAND; THYLSTRUP, 1991) e três anos (CARVALHO; THYLSTRUP; EKSTRAND, 1992) de acompanhamento, os resultados foram mantidos. Resultados semelhantes foram encontrados por MALTZ e colaboradores (2003). Ao avaliar o efeito de um programa de tratamento individualizado para controle de lesões em superfícies oclusais de primeiros molares permanentes em erupção, foi observada uma significativa redução do número de lesões ativas dois anos após o tratamento (MALTZ *et al*., 2003)

Dois trabalhos clássicos evidenciaram a possibilidade de controlar lesões cariosas cavitadas. Em uma série de casos com 40 pacientes, publicada na década de 30, ANDERSON (1938) procedeu à exposição da dentina cariada em dentes com lesões cavitadas utilizando apenas instrumentos manuais. Seu objetivo foi permitir que os próprios pacientes, que não teriam acesso ao tratamento restaurador, pudessem limpar o interior das cavidades durante a escovação. Após um período de 3 anos, foi observada a inativação total ou parcial das lesões e a diminuição da sensibilidade relatada pelos pacientes. NYVAD e FEJERSKOV (1986) trataram de modo não invasivo 24 lesões cariosas radiculares em 10 pacientes adultos. O tratamento, baseado em aplicações de solução de fluoreto de sódio e escovação com dentifrício fluoretado, foi capaz de promover a inativação das lesões após 18 meses, sendo que foi possível observar o escurecimento e o endurecimento da dentina em um período de 2 a 3 meses.

Outros estudos que avaliaram a implementação de abordagens não invasivas, baseadas na educação do paciente para o controle dos fatores etiológicas da cárie; remoção mecânica do biofilme dental, caseira e/ou profissional; identificação de sítios e períodos de risco, como molares permanentes em erupção; fluorterapia; selantes oclusais; etc; demonstraram a eficácia deste tipo de abordagem, desde que a doença seja diagnosticada em estágios precoces de desenvolvimento (FLÓRIO *et al*., 2001; EKSTRAND e CHRISTIANSEN, 2005).

Com base nestas evidências, pode-se concluir que toda lesão cariosa é passível de controle, independente de sua localização ou de sua profundidade, sejam elas lesões coronárias ou radiculares, não cavitadas ou cavitadas. Embora nenhuma intervenção invasiva seja necessária, esta abordagem requer atuação efetiva e ativa do profissional na realização de reavaliações periódicas, fundamentais no sentido de verificar as modificações que ocorrem nas características clínicas da lesão, indicativas da sua paralisação. Há ainda que se ressaltar que a indicação de abordagens restauradoras pode relacionar-se a aspectos referentes à impossibilidade de inativação da lesão pelo não acesso à remoção do biofilme dentário, à recuperação da função mastigatória, da estética ou da resistência da peça dentária e ainda ao controle da sensibilidade dolorosa.

Lesões não cavitadas inativas

Apesar das consistentes evidências demonstrando a possibilidade de paralisar as lesões cariosas mediante a adoção de estratégias de tratamento não invasivo, pouco se sabe sobre a evolução das lesões cariosas inativas ao longo do tempo.

KOULOURIDES e CAMERON (1980) demonstraram que o esmalte dentário sofre adaptação mediante o desafio ácido a que é submetido, uma vez que áreas portadoras de lesões cariosas não cavitadas, previamente desenvolvidas e consolidadas, mostraram-se mais resistentes a novo desafio ácido do que áreas de esmalte hígido contíguas a elas. MALTZ e colaboradores (2006) demonstraram, em um estudo *in situ*, que lesões cariosas ativas não cavitadas recuperaram parte significativa da microdureza knoop superficial quando inativadas. Apesar do aumento de microdureza, estas lesões apresentaram, após um período de 75 dias, dureza superficial menor do que a da superfície hígida. No entanto, quando comparou-se a perda de microdureza de superfícies hígidas com as de lesões controladas frente a um novo desafio cariogênico, as lesões inativas apresentaram perda de microdureza inferior à do esmalte hígido. Estes resultados sugerem que lesões cariosas não cavitadas, uma vez inativadas, tornam-se mais resistentes a novos desafios cariogênicos, o que poderia dispensar cuidados clínicos adicionais.

Poucos estudos longitudinais avaliaram a evolução das lesões inativas ao longo do tempo. Em um estudo longitudinal, NYVAD e colaboradores (2003) demonstraram a capacidade inibitória de cárie de um programa de escovação supervisionada com dentifrício fluoretado em crianças de 12 anos e a validade de um critério de diagnóstico clínico para determinação da atividade das lesões. Neste estudo, os autores observaram que 3% das lesões inicialmente diagnosticadas como não cavitadas inativas permaneceram não cavitadas em um período de três anos, entretanto migraram para lesões não cavitadas ativas e 27% para cavitadas/restaurações, em contraste com uma taxa de progressão de 5% das superfícies hígidas.

Com o propósito de avaliar a história natural da cárie dentária, FERREIRA-ZANDONÁ e colaboradores (2012) acompanharam 338 crianças porto-riquenhas por 48 meses utilizando o sistema ICDAS para a detecção das lesões cariosas. Os autores encontraram que o grau de progressão das lesões em direção à cavitação foi desigual entre aquelas com diferentes severidades, atividade presente ou não e em diferentes superfícies dentárias. Os índices de progressão mostraram uma relação direta com a severidade expressa pelo escore ICDAS e com a atividade presente no exame inicial. As lesões não cativadas inativas apresentaram taxas de progressão de 37% e 41% para ICDAS graus 1 e 2, respectivamente, em comparação a uma taxa de 13% observada nas superfícies hígidas. Em que pese a importância dos achados deste estudo, eles devem ser considerados com cautela, tendo em vista a reprodutibilidade inter-examinadores relatada pelos autores, com valores de kappa variando entre 0,54 e 0,62, a qual pode ter impactado o diagnóstico das lesões cariosas oclusais inativas, que apresentaram taxas de progressão significativamente maiores que as superfícies oclusais hígidas.

Tanto no trabalho de FERREIRA-ZANDONÁ e colaboradores (2012) como no de NYVAD e colaboradores (2003), o diagnóstico das superfícies oclusais não foi realizado dirigido a seus diferentes sítios anatômicos. Desta forma, para cada superfície é gerado um dado que define seu estado clínico em determinado momento observacional. No entanto, considerando-se a riqueza anatômica das superfícies oclusais de molares permanentes, comumente observa-se que diferentes sítios de uma mesma superfície apresentam condições diversas no que concerne à presença, severidade e atividade cariosa. CARVALHO e colaboradores (1989), ao estudar a associação entre grau eruptivo de molares permanentes e acúmulo de placa em suas superfícies oclusais identificaram os diferentes sítios destas superfícies e o acúmulo de placa sobre eles. Da mesma forma, os mesmos autores (CARVALHO; EKSTRAND; THYLSTRUP, 1991; CARVALHO;

THYLSTRUP; EKSTRAND, 1992), ao estudar a progressão de lesões cariosas em superfícies oclusais de molares permanentes por períodos de 1 e 3 anos identificaram situações clínicas diversas em diferentes sítios da mesma superfície oclusal. No momento atual, a falta de estudos que diferenciem os diversos sítios destas superfícies oclusais pode ser vista como uma limitação das evidências disponíveis quanto ao comportamento clínico de lesões cariosas não cavitadas.

Tendo em vista a reduzida quantidade de estudos clínicos longitudinais sobre o comportamento das lesões cariosas inativas, novos estudos sobre o tema são necessários. Parece imperioso, do ponto de vista clínico, compreender se tais lesões são apenas cicatrizes de processos desmineralização-remineralização vivenciados no passado, se são superfícies mais resistentes a um novo desafio cariogênico, ou se são mais suscetíveis aos desafios cariogênicos do que o esmalte hígido.

Erupção e cárie dentária

Considerando a natureza multifatorial da cárie dentária, aspectos comportamentais e orais parecem desempenhar papéis importantes na determinação do risco de indivíduos e sítios dentários ao desenvolvimento da doença. Dentre eles, destaca-se o período de erupção dos molares permanentes.

O estudo transversal de CARVALHO e colaboradores (1989) estabeleceu a associação entre grau eruptivo e acúmulo de biofilme em superfícies oclusais de molares permanentes. Dentes parcialmente erupcionados mostraram acúmulo de placa significativamente maior do que aqueles em oclusão funcional. Os autores também demonstraram que as áreas de maior acúmulo de biofilme coincidiam com as áreas mais afetadas pela cárie dentária. A partir destes achados, pôde-se inferir a relação entre estágio eruptivo e cárie dentária.

Embora o estágio eruptivo seja citado como um fator de risco para a cárie dentária, determinando uma “idade de risco” para o seu desenvolvimento, nenhum estudo avaliou a associação entre acúmulo de biofilme, estágio eruptivo e presença de lesões cariosas ativas por meio de modelos multivariados, os quais permitem que sejam feitos ajustes entre os possíveis fatores causais.

OBJETIVOS

Objetivo geral

Estudar o comportamento clínico da cárie dentária em superfícies oclusais de molares permanentes.

Objetivos específicos

- Avaliar a acurácia e reprodutibilidade de um índice visual para o registro do acúmulo de biofilme em superfícies oclusais (ARTIGO I);
- Avaliar o efeito independente do acúmulo de biofilme e do estágio eruptivo na atividade de cárie em superfícies oclusais de molares permanentes (ARTIGO II);
- Comparar as taxas de incidência/progressão de cárie em superfícies oclusais hígidas e lesões cariosas inativas em molares permanentes ao longo de 12 meses (ARTIGO III);
- Avaliar o risco de incidência/progressão de cárie em superfícies oclusais hígidas e lesões cariosas inativas em molares permanentes ao longo de 12 meses (ARTIGO III).

Accuracy and reproducibility of a visual index to assess biofilm accumulation on occlusal surfaces

Accuracy and reproducibility of a visual index to assess biofilm accumulation on occlusal surfaces

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Summary

Occlusal indexes to assess biofilm accumulation advocate biofilm staining. This additional step makes the technique more expensive and time-consuming. Furthermore, colored dyes may stain the occlusal surface, which might difficult the adequate detection of incipient caries lesions during the same appointment. This study aimed to assess the accuracy and reproducibility of a simplified, visual index to assess biofilm accumulation on occlusal surfaces. Biofilm accumulation on occlusal surfaces of 80 permanent molars was visually assessed by one single examiner and scored as follows: (0) no visible biofilm; (1) hardly detectable biofilm, restricted to grooves and fossae; (2) biofilm easily detectable in grooves and fossae; and (3) occlusal surface partially or totally covered with heavy biofilm accumulations. Clinical examinations were performed three times, using no detector dye in the first and second examinations, and using 7% fuchsine in the third examination as the gold standard. Repeated analysis showed that the index under study is reproducible (k=0.8). There was a high degree of agreement between the two methods (with and without dye) (k=0.7). Dichotomization according to the presence/absence of thick biofilm yielded sensitivity, specificity, accuracy, positive and negative predictive values ≥ 0.95. Biofilm accumulation on occlusal surfaces of permanent molars can be visually assessed in an accurate and reproducible way. The use of a detector dye may not be necessary.

Key words: dental plaque, indexes, occlusal surface, diagnostic studies.

Introduction

In spite of the significant decrease lately observed in the prevalence and progression rates of dental caries (1,2), its occurrence on occlusal surfaces remains a challenge for dental professionals (3). The occlusal surface has relatively protected areas, which favor biofilm accumulation (4). Dental biofilm is the main etiological factor in dental caries, and should be assessed in the diagnosis, prevention and treatment of the disease. Carvalho et al. (5) have described a correlation between thick biofilm on the occlusal surfaces of permanent molars and caries lesion, pointing to the importance of assessing dental biofilm in caries diagnosis and to the need of a useful diagnostic tool to achieve this goal.

Unlike biofilm indexes designed for smooth surfaces (6,7), which do not use detector dyes, those assessing occlusal biofilm advocate biofilm staining (5,8-10). This additional step turns the technique more expensive and time-consuming. Furthermore, colored dyes may stain the occlusal surface, which might difficult the adequate detection of incipient lesions during the same appointment. The validation of a visual index to assess biofilm accumulation without using any dye may therefore be useful in both clinical practice and diagnostic studies.

The aim of the present study was to assess the accuracy and reproducibility a simplified, visual index to assess biofilm accumulation on occlusal surfaces.

Material and Methods

Clinical examination

The sample comprised 80 unrestored permanent molars from 11 patients. Dental biofilm was examined in the school dental clinic without previous notice. Clinical examination was conducted by a single examiner at a dental unit, using artificial light and a dental mirror. After tooth drying, the occurrence of visible biofilm on the occlusal surface was scored as follows: (0) no visible biofilm; (1) hardly detectable biofilm, restricted to grooves and fossae; (2) biofilm easily detectable in grooves and fossae; and (3) occlusal surface partially or totally covered with heavy biofilm accumulations (5). Clinical examinations were performed three times, using no detector dye in the first and second examinations, and using 7% fuchsine (Eviplac, Biodinâmica, Ibiporã, PR, Brazil) in the third examination (gold standard). The detector dye was applied on the occlusal surface for 5 seconds using cotton pellets and then rinsed with water. The minimal time interval between examinations was 90 minutes and the order of participants changed from one examination to another (8). Patients were told to avoid drinking or eating and not to perform oral hygiene procedures until the moment of the third recording.

Data analysis

Cohen's kappa was used to evaluate agreement between the two detection methods (with and without dye) and to assess intra-examiner reproducibility of the index under study.

Sensitivity, specificity, accuracy, positive and negative predictive values were calculated for each score. Biofilm assessment using 7% fuchsine dye was used as the gold standard.

The index was dichotomized as follows: scores 0 and 1 = absence of thick biofilm; scores 2 and 3 = presence of thick biofilm. Diagnostic measures were calculated for the dichotomized index as described above.

Data analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 13.0, for Windows.

Results

There was a high degree of agreement between the two examinations without dye (kappa = 0.8).

Agreement between the two detection methods was substantial (kappa = 0.7). The association between assessments with and without dye is shown in Table 1.

Specificity, accuracy, positive and negative predictive values were ≥ 0.81 for all scores (Table 2). Sensitivity was ≤ 0.68 for scores 0 and 1, and ≥ 0.84 for scores 2 and 3.

When the index was dichotomized according to the presence/absence of thick biofilm, all diagnostic measures increased: sensitivity = 0.95; specificity = 0.97; accuracy = 0.96; positive predictive value = 0.97; and negative predictive value = 0.95.

Discussion

This study assessed the accuracy and reproducibility of a simplified, visual method to assess biofilm accumulation on the occlusal surfaces of permanent molars in comparison with an index previously developed (5). The clinical significance of this study results from the increasing incidence of non-cavitated carious lesions (11) and their association with biofilm accumulation (5,9,10)

Other indexes to assess biofilm accumulation on occlusal surfaces have been developed and tested (8,12). The index described by Addy et al. (8), for example, used six categories according to different degrees of biofilm coverage of the fissure system. In turn, the one developed by Levinkind et al. (12) divided the occlusal surfaces of molar teeth into 9 zones according to an imaginary grid. Although site-specific, these indexes are more complex and become difficult to use in routine clinical practice. Occlusal biofilm indexes advocate the use of dyes; however, the resulting tooth staining could difficult caries examination. Photo-activated colorless substances have been used (5,13), however, they require the use of specific equipment, such as halogen lights. The simplified index proposed in this study has several advantages once it is simple to use, do not stain the tooth and do not require specific technologies.

Any new diagnostic method has to be reproducible and validated by testing its ability to correctly identify positive and negative cases when compared to a method previously known, referred to as the gold standard. To achieve this goal, specificity, sensitivity, accuracy and predictive values should be calculated (14). In this study, biofilm assessment using a detector dye was the gold standard, because it has been shown to effectively detect minimal biofilm accumulations in previous studies (15,16).

The index under study proved to be reproducible (kappa = 0.8). Both positive and negative predictive values were ≥ 0.81 for every score. At the same time, it accurately detected the absence of dental biofilm (specificity ≥ 0.93 for all scores). The analysis of sensitivity revealed that the visual index accurately detected thick biofilm (scores 2 and 3), but was less effective in detecting sites without biofilm (score 0) or with a thin biofilm (score 1). Considering the correlation between biofilm accumulation and dental caries and that caries was usually observed under thick biofilm (5), the index was dichotomized into presence or absence of thick biofilm. After dichotomization, sensitivity increased to ≥ 0.95. These findings suggest that the best performance of this simplified, visual index is to detect dental biofilm related to dental caries.

In conclusion, the present findings have shown that biofilm accumulation on occlusal surfaces can be assessed accurately and in a reproducible way using the simplified, visual index. The use of a detector dye may not be necessary.

Resumo

Os índices para avaliação do biofilme oclusal preconizam a utilização de corantes. Este passo adicional torna a técnica mais dispendiosa e demorada. Além disto, evidenciadores coloridos podem manchar a superfície oclusal, o que poderia dificultar a adequada detecção de lesões cariosas não cavitadas durante a mesma sessão clínica. Este estudo objetivou avaliar a acurácia e reprodutibilidade de um índice visual simplificado para avaliar a presença de biofilme nas superfícies oclusais. Avaliou-se visualmente o acúmulo de biofilme nas superfícies oclusais de 80 molares permanentes de acordo com os escores a seguir: (0) ausência de biofilme visível; (1) biofilme dificilmente visível, restrito às fossas e sulcos; (2) biofilme facilmente detectável em fossas e sulcos e (3) superfície oclusal parcialmente ou totalmente coberta por biofilme. As avaliações clínicas foram executadas três vezes, sem uso de evidenciador no primeiro e no segundo exames e usando Fucsina a 7% na terceira observação, como padrão ouro. As análises repetidas demonstraram que o índice avaliado é reprodutível (k=0.8). Houve um alto grau de concordância entre os dois métodos utilizados (com e sem evidenciador) (k=0.7). A dicotomização a partir da presença ou ausência de biofilme espesso obteve sensibilidade, especificidade, acurácia e valores preditivos positivo e negativo ≥ 0.95. Acúmulos de biofilme em superfícies oclusais de molares permanentes podem ser visualmente avaliados de modo acurado e reprodutível. O uso de um corante evidenciador pode não ser necessário.

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Table 1

Table 1. Distribution of biofilm scores detected with and without dye.

Without dye	With dye				
	0	1	2	3	Total
0	10	8	0	0	18
1	1	20	2	0	23
2	0	1	18	3	22
3	0	0	1	16	17
Total	11	29	21	19	80

Table 2

Table 2. Diagnostic measures for each score.

Diagnostic measure	Biofilm score			
	0	1	2	3
Sensitivity	0.55	0.68	0.85	0.84
Specificity	0.98	0.94	0.93	0.98
Accuracy	0.88	0.85	0.91	0.95
Positive predictive value	0.90	0.86	0.81	0.94
Negative predictive value	0.88	0.84	0.94	0.95

Influence of eruption stage and biofilm accumulation on occlusal caries in permanent molars: A GEE logistic approach

Original Paper

Caries Research

Caries Res 2013;47:177–182
DOI: 10.1159/000345076

Received: May 7, 2012
Accepted after revision: September 29, 2012
Published online: December 5, 2012

Influence of Eruption Stage and Biofilm Accumulation on Occlusal Caries in Permanent Molars: A Generalized Estimating Equations Logistic Approach

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Key Words

Biofilms · Caries detection · Plaque index

Abstract

The aim of this study was to estimate the independent effects of biofilm accumulation and eruption stage on the occurrence of active caries lesions on occlusal surfaces of permanent molars. The sample consisted of 298 schoolchildren (6–15 years) who were examined by a calibrated examiner at a dental unit, using artificial light, a dental mirror and a WHO probe. The occurrence of visible biofilm on occlusal surfaces and the eruption stage of each permanent molar were recorded. After professional prophylaxis and air drying, the occlusal surfaces were classified as sound, caries-inactive or caries-active. To evaluate the association of eruption stage and biofilm accumulation with active caries lesions, a logistic regression model was used. Since data were clustered, odds ratios were obtained using generalized estimating equations with a logistic link function. 1,779 permanent molars were examined. All eruption stages were associated with active caries lesions. After adjustment for biofilm accumulation and type of molar, molars with occlusal surfaces partially exposed to the oral cavity were 63.6 times more susceptible to caries activity than molars with full occlusion (95% CI = 22.0–183.7). After adjustment for eruption stage and type of molar, teeth with a high degree of biofilm accumulation were 14.5 times more susceptible to caries activity than those without visible biofilm accumulation (95% CI = 6.5–32.4). No association between active caries and hardly detectable biofilm was found in this population. The present study found that the eruption stage of permanent molars is strongly associated with active caries lesions, adjusted for biofilm accumulation and type of molar.

The multifactorial nature of dental caries and the behavioral aspects associated suggest that individual susceptibilities to the disease may vary. Differences in type of teeth, dental surfaces, and ages of the individuals seem to play a role in the susceptibility to dental caries. Carvalho et al. [1989], in a classic cross-sectional study, observed a strong association between biofilm accumulation on occlusal surfaces and the eruption stage of permanent molars. Partially erupted teeth showed a signifi-

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Fig. 1. Example of sound (**a**), caries-inactive (**b**) and caries-active (**c**) permanent molars.

cantly high degree of biofilm accumulation, and teeth that showed full occlusion had markedly lower levels of easily detectable biofilm. The distribution pattern of active caries lesions also appeared to be closely related to the distribution pattern of dental biofilm.

The relationship between the eruption stage and dental caries has been studied in longitudinal trials. Dirks [1966], who studied buccal surfaces of first permanent molars, observed the arrestment and/or regression of the lesions as a result of changes in the oral environment during tooth eruption. Similar findings were observed on occlusal surfaces [Carvalho et al., 1991, 1992; Maltz et al., 2003].

The eruption stage of the first and second permanent molars has been assessed as a risk factor for the development of dental caries [Varsio et al., 1999; Ekstrand et al., 2003; Frazão, 2011]; however, direct evaluation of this aspect has not been performed in a study to date. Carvalho et al. [1989] showed significant relationships between eruption stage and biofilm and between biofilm and caries. Based on these findings, the relationship between eruption stage and caries was inferred; however, no study has described the relationships among biofilm accumulation, eruption stage, and active caries lesions using multivariate models. Therefore, the aim of the present study was to estimate the independent effects of biofilm accumulation and eruption stage on the occurrence of active caries lesions on occlusal surfaces of permanent molars.

Subjects and Methods

This study used a cross-sectional design and its sample comprised 298 children aged 6–15 years who were attending a public school in Santa Maria, Brazil. Santa Maria is a medium-sized city located in Southern Brazil, with an estimated population of around 262,368 habitants in 2011. Caries experience in this population can be considered low. According to the WHO criteria, caries prevalence is 23.5% in preschool children [Piovesan et al., 2010], reaching 39.3% in 12-year-olds [Piovesan et al., 2011].

Sample Size Calculation

A sample of 146 individuals was considered necessary to detect an odds ratio (OR) of 2.5, comparing the extreme categories of eruption with a baseline caries rate of 8% to achieve a statistical power of 80% and a confidence level of 95%. Considering the design effect for clustering of 2.0, the sample size increased to 292 schoolchildren.

Clinical Examination

The schoolchildren were examined using a light source, a dental mirror and a WHO probe by a single examiner at a dental unit. First, the occurrence of visible biofilm on occlusal surfaces was visually examined and scored as follows: (0) no visible biofilm; (1) hardly detectable biofilm restricted to the grooves and fossae; (2) easily detectable biofilm in the grooves and fossae; and (3) occlusal surfaces partially or totally covered with heavy biofilm accumulation [Carvalho et al., 1989]. The eruption stage of each permanent molar was recorded as follows: (0) unerupted; (1) partially erupted occlusal surface; (2) fully erupted occlusal surface with less than half of the facial surface of the tooth covered with gingival tissue; (3) fully erupted occlusal surface with more than half of the facial surface of the tooth covered with gingival tissue; and (4) full occlusion [Carvalho et al., 1989]. After administering professional prophylaxis and performing air drying, the occlusal surfaces were classified as sound, caries-inactive or caries-active, as exemplified in figure 1. Active caries was defined as opaque enamel with a dull whitish surface while inactive caries was defined as a white or brownish lesion with shiny appearance [Carvalho et al., 1989]. Only noncavitated lesions and enamel cavities were included in the study (ICDAS codes 1, 2 and 3). Molars with dentin cavities (n = 39) filled (n = 106), sealed (n = 4) or hypoplastic (n = 4) were excluded.

Reproducibility

Before the beginning of the study, the examiner performed training and calibration for the used indexes. To assess intraexaminer reproducibility, repeated examinations were conducted in 101 permanent molars. The minimal time interval between examinations was 90 min for biofilm index, and 2 days for eruptive stage and caries examination. The following Cohen's kappa (unweighted) was obtained: 0.78 for biofilm index, 0.86 for eruption stage and 0.78 for caries detection/activity.

Data Analysis

Quantitative data were presented as mean and standard deviation values. When the data showed skewness, we used median and interquartile range. Categorical data were presented as counts and percentages. The relationship between biofilm coverage and eruption stage was assessed using Spearman's rank correlation coefficient (r_S). The occurrence of active caries lesions was considered as a binary variable. Sound occlusal surfaces and caries-inactive occlusal surfaces, both of which indicated absence of active lesions, were combined in the same category. A logistic regression model was used to evaluate the association of eruption stage and biofilm accumulation with the presence of active caries lesions. In order to adjust the estimates for the type of molar (first vs. second), this variable was included in the multivariate model. Since the data were clustered (data for a particular number of observation sites were obtained from each patient), ORs were obtained using generalized estimating equations with a logistic link function. The data were analyzed using the Statistical Package for the Social Sciences software, version 17.0.

Ethical Considerations

This study was approved by the Federal University of Santa Maria Research Ethics Committee (243/2008). All participants and their parents/legal guardians provided written informed consent.

Table 1. Sample description

Characteristic	Statistic
Age	
Mean ± SD	12.4 ± 2.4
6–10 years	70 (23.5%)
11–15 years	228 (76.5%)
Gender (M/F), %	52/48
Teeth/patient	
Mean ± SD	6.0 ± 2.0
Median (P25–P75)	6 (4–8)
Range	2–8
Total teeth	1,779
Active lesion	150 (8.4%)

Table 2. Distribution of permanent molars according to dental biofilm index and eruption stage

Biofilm	Eruption 1	2	3	4	total
0	9 (13.6)	13 (18.8)	47 (34.3)	1,088 (72.2)	1,157 (65.0)
1	3 (4.5)	10 (14.5)	38 (27.7)	173 (11.5)	224 (12.6)
2	9 (13.6)	17 (24.6)	35 (25.5)	152 (10.1)	213 (12.0)
3	45 (68.2)	29 (42.0)	17 (12.4)	94 (6.2)	185 (10.4)
Total	66	69	137	1,507	1,779

Data are presented as counts (with percentages in parentheses). $r_S = -0.39$; $p < 0.001$.

Results

The characteristics of the schoolchildren are listed in table 1. In the 298 schoolchildren, 1,779 permanent molars were examined, with an average of 6 teeth per child. Active caries lesions were detected in 8.4% of the examined teeth (n = 150).

The proportion of dental biofilm accumulation in each eruption stage is listed in table 2. A significant inverse correlation was observed between accumulation of dental biofilm and eruption stage ($r_S = -0.39$; $p < 0.001$). Until eruption stage 3, most teeth showed biofilm accumulation. However, in most cases of eruption stage 4, no visible biofilm accumulation was observed. Figure 2 shows the proportion of active caries lesions according to biofilm accumulation and eruption stage. The proportion of active lesions increases with biofilm accumulation and decreases when the molars reach full occlusion.

The association between active caries lesions, eruption stage, biofilm accumulation and type of molar is shown in table 3. Active caries lesions were associated with all stages of eruption. After adjusting the data for the effect of biofilm accumulation and type of molar, molars with occlusal surfaces partially exposed to the oral cavity (score 1) were 63.6 times more susceptible to caries activity than molars in full occlusion. Easily detectable biofilm was associated with active caries. After adjusting the data for the effect of eruption stage and type of molar, teeth with a high degree of biofilm accumulation (score 3) were 14.5 times more susceptible to caries activity than those

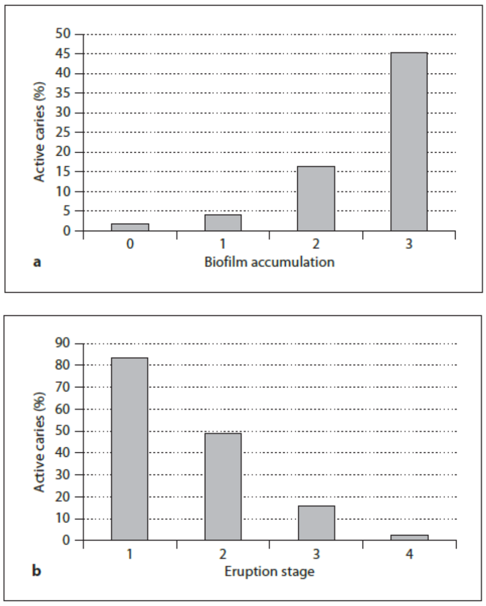

Fig. 2. Proportion of active caries lesions according to biofilm accumulation (**a**) and eruption stage (**b**).

Table 3. Association between active caries lesions on occlusal surfaces of permanent molars according to eruption stage and biofilm accumulation

Variable	Teeth	Active lesions	OR	95% CI	p
Eruption index					
1	66	55 (83.3%)	63.6	22.0–183.7	<0.001
2	69	34 (49.3%)	14.9	7.1–31.2	<0.001
3	137	22 (16.1%)	4.1	2.0–8.4	<0.001
4	1,507	39 (2.6%)	1.0	–	
Biofilm index					
0	1,157	22 (1.9%)	1.0	–	
1	224	9 (4.0%)	1.9	0.8–4.3	0.12
2	213	35 (16.4%)	5.5	2.5–12.3	<0.001
3	185	84 (45.4%)	14.5	6.5–32.4	<0.001
Type of molar					
First	981	33 (3.4%)	1.0	–	
Second	798	117 (14.7%)	1.9	1.0–3.5	0.05

OR obtained in a logistic regression model based on generalized estimating equations.

without visible biofilm accumulation. We did not observe any association between active caries and hardly detectable biofilm (score 1) in this population. An association was found between type of molar and caries activity ($p = 0.05$), with second molars being 1.9 times more likely to present active caries lesions than did first molars, after adjustment for eruption stage and biofilm.

Discussion

This study was carried out to estimate the independent effects of biofilm accumulation and eruption stage on the occurrence of active caries lesions on occlusal surfaces of permanent molars. Thick biofilm accumulation was observed to be directly associated with the presence of active caries lesions, whereas a strong inverse association was observed between the eruption stage and active caries. To the best of our knowledge, this is the first study to assess the independent contribution of eruption stage and biofilm accumulation on the occurrence of active caries by using a multivariate model.

Since the early stages of eruption and the thickness of the accumulated biofilm may show some colinearity [Carvalho et al., 1989], adequate adjustments of the estimates are required. Multivariate logistic regression models are the statistical procedure of choice to assess the association between 2 or more factors and a binary end point. Furthermore, adequate management of dependent data is a main issue in dental clinical research, considering the great number of observations obtained from each patient. Considering the data as independent data may lead to a bias in the assumed strength of the defined associations [Leroy et al., 2005]. Adopting generalized estimating equations with a logistic link was the approach of choice to manage the clustering of the data from this study.

Carvalho et al. [1989] observed an association between eruption stage and biofilm accumulation and between active caries lesions and biofilm accumulation, which implied an association between eruption stage and dental caries. The logistic regression model that we used allowed a proper adjustment of the estimated effects and quantification of the independent influences of biofilm accumulation and the eruption stage of permanent molars on the susceptibility to active caries lesions. We found a significant association between active caries and easily detectable biofilm (scores 2 and 3) and no association between active caries and hardly detectable biofilm (score 1). These findings indicate that a thin biofilm does not promote a cariogenic challenge. The thicker the biofilm accumulation, the higher are the chances of development of active caries (score 2, OR = 5.5, 95% CI = 2.5–12.3; score 3, OR = 14.5, 95% CI = 6.5–32.4). It is well known that a mature biofilm covering dental surfaces can easily promote an acidic challenge. In cases involving a sucrose challenge, for example, dental biofilm must be at least 2 days old before they can produce acid levels sufficient to cause demineralization of enamel [Imfeld and Lutz, 1980]. Leroy et al. [2005] have reported an association between cavity formation and biofilm accumulation completely covering the occlusal surfaces. This association was stronger than that between cavity formation and biofilm accumulation covering only pits and fissures. Their results, similar to ours, show the association between the amount of dental biofilm and caries lesions.

In a recent clinical report on biofilm formation and its distribution and maturation in the primary, mixed and permanent dentitions, a close relationship between biofilm and eruption stage was reinforced [Carvalho et al., 2009]. The authors found a significant difference in biofilm scores between partially erupted first molars at the age of 6 years and first molars showing full occlusion at the age of 12 years, with a marked reduction in the occurrence of thick biofilm in the latter group. Finally, permanent first and second molars in full occlusion showed limited accumulation of occlusal biofilm (score 1) at the age of 15 years. It is important to highlight that in the present study, clinical examinations were performed without previous notice, thus recording the amount of biofilm naturally found at those surfaces. Unlike the studies by Carvalho et al. [1989, 2009], which recorded biofilm accumulation after 48 h without oral hygiene (assessing strictly the effect of eruption stage), our study assessed the effect of eruption stage of permanent molars, the difficulty of brushing these teeth as well as the oral hygiene measures usually performed by the included individuals. It could be argued that the position in the mouth could influence caries occurrence, since first permanent molars could be more easily cleaned during eruption than second permanent molars. Based on this assumption, we included the type of molar in the multivariate model, and a borderline association was found. The type of molar may have some influence on caries occurrence, but both the magnitude and significance of such association were extremely lower than those found for eruption stage and easily detectable biofilm. These findings provide evidence that eruption and biofilm are features much more important for caries activity than type of molar.

A previous study has indicated that the eruption stage plays a role in caries development, even in the absence of visible biofilm [Brailsford et al., 2005]. In molars with no visible biofilm, the proportion of sound surfaces to caries-active surfaces for fully erupted teeth was 78 versus 22%, whereas this proportion was 54 versus 46% for partially erupted teeth. In the present study, even after adjusting the data for the effect of biofilm accumulation and type of molar, all the stages of eruption showed significant associations with the occurrence of active caries, with the odds decreasing as the teeth approached full occlusion. These findings show the effect of eruption stages on the development of dental caries. It is important to clarify that the multivariate model adjusted the estimate of association between eruption stage and occlusal caries activity for biofilm accumulation, but it does not mean that eruption stage may cause dental caries irrespective of biofilm coverage and that eruption stage is more important than biofilm coverage. It means that, in the same category of the biofilm index, eruption stage promoted a greater effect (OR) than did biofilm accumulation in the same category of eruption stage.

Klein and Palmer [1941] published a classical study on the categorizing of the susceptibility of different groups of teeth to dental caries. In their classification, lower and upper molars in permanent dentition were, respectively, the most susceptible teeth to dental caries. A recent investigation has confirmed this susceptibility, in spite of the tangible decline in caries prevalence at present [Macek et al., 2003]. It has been observed that 10–25% of all permanent molars in Finnish children were restored within a year of eruption, but this observation was not true for permanent incisors, premolars and canines [Larmas et al., 1995]. The majority of these restorations were placed when the children were aged between 6.5 and 7.0 years, and this trend indicates the need for preventive measures during the eruption of permanent molars. It is likely that the majority of active lesions arrest as the teeth achieve the occlusal plane. However, in the present study, 145 permanent molars in full occlusion presented dental cavities or fillings. Furthermore, a previous longitudinal study showed that around 25% [Maltz et al., 2003] of the active noncavitated lesions progressed to cavities/fillings over a 2-year period. The fact that partially erupted permanent molars are more susceptible to occlusal caries than those in full occlusion leads to the recommendation that special attention be provided for the prevention, early diagnosis and monitoring of dental caries in these teeth. It is important to point out that caries development is a cumulative and slow process. Therefore, application of caries-preventive strategies should not be restricted to the eruption period [Leroy et al., 2005].

In this study, we found that the eruption stage of permanent molars is strongly associated with the development of active caries lesions adjusted for biofilm accumulation and type of molar.

Disclosure Statement

The authors declare that they have no proprietary, financial, professional or other personal interest of any nature or kind in any product, service and/or company that could be construed as influencing the position presented in this study

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One-year evaluation of inactive occlusal enamel lesions in children and adolescents

One-year evaluation of inactive occlusal enamel lesions in children and adolescents

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Running head

One-year evaluation of inactive occlusal enamel lesions

Key words

Inactive lesions, occlusal surfaces, caries risk, caries progression, clinical study, permanent molars.

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Declaration of interest

The authors declare no conflict of interest related to this study.

ABSTRACT

Background: Little is known on the fate of inactive enamel lesions on the occlusal surfaces of permanent molars over time. Aims: To compare caries incidence and progression on sound occlusal surfaces and on surfaces presenting inactive enamel lesions and to estimate the risk of caries incidence and progression on these surfaces. Design: This prospective cohort study followed 200 7-15-yr-old caries-inactive schoolchildren over 1 year. Stage of eruption, occlusal plaque, and occlusal caries were recorded on permanent molars. Statistical analysis was performed using generalized estimating equations with a logistic link function. Results: 22 children (11%) presented “caries progression” (at least one active lesion on molar teeth). At site level, no difference was observed in caries incidence and progression between sites classified either sound (2.6%) or with inactive enamel lesion (3.9%) at the baseline examination (χ^2 test, p=0.48). Adjusted for plaque, stage of eruption, type of molar and dental arch, inactive enamel lesions presented a similar risk for caries progression than sound occlusal surfaces (OR=0.98, 95%CI=0.40-2.38). Conclusion: Occlusal surfaces harboring inactive caries lesions do not require additional attention than the one normally given to sound occlusal surfaces over a 12-months period.

INTRODUCTION

The assessment of caries activity in clinical research has been the subject of growing interest in the contemporary literature (1-5). Caries activity is determined by lesion characteristics that indicate whether or not there is ongoing mineral loss (6, 7).

Lesion activity assessment supports treatment decisions and implementation of strategies to control caries progression according to individual needs. In this context, *in vitro* and *in situ* studies applying different forms of topical fluoride demonstrated that, once inactivated, a lesion had higher acid resistance to new cariogenic challenges than sound enamel. This finding was to a large extent explained by the ability of fluoridated mineral to reduce demineralization and enhance remineralization (8-12).

The assumption that inactive lesions present equivalent or lower risk of caries progression than sound surfaces may have clinical implications in treatment decisions of caries-inactive individuals. A major concern of researchers and clinicians is the risk of caries progression of inactive lesions on occlusal surfaces of molars.

However, clinical trials in low caries prevalence children who benefited from a non-operative occlusal caries treatment program did not show caries progression in 80% and 90% of the observed sites after 1 and 3 years, respectively (1, 13). Most inactivated lesions remained inactive during the study period (1, 13). In these studies, the localization of caries lesions on occlusal surfaces followed that of individual anatomical sites of the groove-fossa-system, thus assuring an accurate long term follow-up of individual lesions. The same trends were observed in children with high caries prevalence who received non-operative treatment during 2 years (14).

The present study was undertaken to gather evidence about the one year outcome of inactive occlusal enamel lesions in children and adolescents with regular access to fluoride. The rationale was to obtain a scientific basis to recommend or not 1 year recall visits of caries-inactive individuals in daily practice. On this basis, patient, practitioner and insurance organizations would benefit from a better allocation of economic and human resources The aims of this study were: 1) to compare caries incidence and progression on sound occlusal surfaces and on surfaces presenting inactive enamel lesions; and 2) to estimate the risk of caries incidence and progression on occlusal surfaces. The null hypothesis was that the risk of caries development and progression on occlusal surfaces of molars teeth presenting inactive enamel lesions was equivalent to those with sound occlusal surfaces.

SUBJECTS AND METHODS

Ethics - The study protocol was approved by the Ethical Committee of the Federal University of Santa Maria, Brazil (Protocol number 243/2008). The school granted authorization to carry out the study, written informed positive consent was obtained from the children's parents or legal guardians, and the children agreed to participate.

Study design, Sample size and selection - The study was designed as a prospective cohort study. The required number of children was estimated based on an expected difference in caries incidence and progression of 15% between sound occlusal surfaces and surfaces with inactive occlusal enamel lesions. Given a power of 80% and a confidence interval of 95%, 100 children with at least one pair of molars were required. A design effect for clustering of 2.0 was considered. A total of 200 children were required at the end of the study. A dropout rate of 25% was added resulting in a final sample of 250 children.

Children were recruited among those attending one public school in the municipality of Santa Maria, Southern Brazil. The selection of this school was based on convenience. The fact that a dental clinic has been installed at the school as part of the service offered by the Federal University of Santa Maria to the local community allowed the researchers to carry out the study at the school premises. The municipality of Santa Maria had a estimated population of 261,031 habitants in 2010 of which 36,151 were aged between 6 and 15 years (15)(15)(15)[15][IBGE, 2012]. In 2011, the caries prevalence at the age of 12 years was 39.3% and the mean number of teeth decayed, missing and filled – DMFT- was 0.9 (16).

Inclusion and Exclusion criteria - All children attending from first to eighth grade were screened and eligible for the study (n= 371). Before the commencement of the study, non-operative and operative treatments of all children were carried out according to individual needs. The inclusion criteria were children presenting a status of caries-inactive dentition with at least one permanent molar with sound occlusal surface and another permanent molar with inactive occlusal enamel lesion (n=258). The inactive enamel lesion might be either non-cavitated or cavitated. In principle, each child might participate in the study having from 2 to 8 permanent molars. A total of 113 children were ineligible since they did not meet the inclusion criteria as illustrated in Fig.1.

Methods and criteria employed for Clinical assessments - The methods and criteria applied for the clinical assessments of permanent molars were: 1) the stage of eruption, 2) the occurrence and distribution of occlusal plaque, and 3) the occurrence and localization of occlusal caries. The stage of eruption of each molar was recorded according to the following: 1) the occlusal surface partially erupted, 2) the occlusal surface fully erupted, but more than half of the tooth facial surface was covered with gingival tissue, 3) the occlusal surface fully erupted, and less than half of the tooth facial surface was covered with gingival tissue, and 4) full occlusion (17).

Initially, the occurrence and distribution of visible occlusal plaque scores was detailed mapped on standardized drawings of the occlusal groove-fossa-system as: 0) no visible plaque, 1) hardly detectable plaque restricted to the groove-fossa-system, 2) easily detectable plaque on the groove-fossa-system, and 3) occlusal surfaces partially or totally covered with heavy plaque accumulation (17). This was followed by a prophylaxis of the children's dentition. The status of the occlusal surfaces was then assessed after air drying. Enamel changes were classified as: 0) normal enamel translucency after air drying, 1) opaque enamel with dull-whitish surface (active lesion, non-cavitated or cavitated), 2) shiny appearance of the surface of the opaque area with different degrees of brownish discoloration (inactive lesion, non-cavitated or cavitated) (17). The occurrence and localization of enamel changes were marked on a separate morphology card in one of two selected anatomical sites of the groove-fossa-system. In maxillary molars the selected anatomical site was either the central or the distal fossa whereas in mandible molars it was either the central fossa or the lingual interlobal groove. These sites were chosen as representative of the occlusal groove-fossa-system due to their highest prevalence and incidence of caries lesions (1, 13). The mapping of enamel changes on the groove-fossa-system allowed the follow-up of individual anatomical site; thus, it was always possible to make a distinction between sound enamel sites and enamel sites with inactive lesion that had progressed to active lesions. Also, an association between occlusal plaque scores and caries progression could be analyzed at individual anatomical sites. These clinical assessments were carried out at the baseline examination in 2010 and one year later in 2011.

Training, Calibration, Reliability and Outcome - One examiner (JEZ), specialist in pediatric dentistry for more than 10 years, was responsible for all clinical assessments. Initially, theoretical training with photographs showing all criteria in different clinical situations was done. This was followed by practical training in which 24 children were examined. Intra-examiner reliability of caries was performed in 7% of the children. Initially, intra-examiner reliability was performed for the plaque index with minimal time interval between examinations of 90 minutes. This was followed by the reproducibility of the stage of eruption of molars teeth and caries diagnosis with an interval between the examinations of two days. Before the clinical examination for caries, which took place at the dental clinic, the children had their teeth professionally cleaned and air dried. Plane mouth mirrors and WHO dental probes were used for the examination.

At the baseline examination, the intra-reliability for the occlusal plaque index obtained a non-weighted Kappa value of 0.78 (95% CI = 0.67-0.89) and of 0.86 for eruption stage (95% CI = 0.77-0.96). Reliability for the diagnosis of occlusal enamel surfaces status was the following: sound surfaces 0.80 (95% CI = 0.68-0.92), surfaces presenting active non-cavitated and cavitated lesions 0.79 (95% CI = 0.63-0.95), surfaces presenting inactive non-cavitated and cavitated lesions 0.75 (95% CI = 0.61-0.90). The overall non-weighted Kappa value for caries examination was 0.78 (95% CI = 0.68-0.89).

The primary outcome of this study was the enamel changes on sound occlusal sites and at sites with inactive occlusal lesions during the study period (Table 1). Enamel changes assessed in terms of activity were classified as: 1) “no changes” when the features of the enamel surface at clinical level were not compatible with mineral loss over the one year of monitoring, 2) “progression” when the features of the enamel surface or caries lesion at clinical level were compatible with mineral loss at one year examination. Enamel changes were measured at child and site levels according to the following definition: (1) child level: changes were identified on any selected occlusal site; (2) site level: changes were observed on at least one selected occlusal site of one molar tooth in the child's mouth. The second outcome was to identify predictors for caries incidence and progression after 1 year.

Access to Fluoride - The children enrolled in the study were resident in a municipality which had been supplied with fluoridated water for more than 30 years. During the study period, the physico-chemical properties of the water were controlled monthly and the content of fluoride ranged from 0.7 to 0.8 ppm F^- (18)(18)(18)[18][CORSAN, 2012]. Fluoride toothpaste containing 1000 ppm F^- was provided to the children during the study period.

Data analysis - The χ^2 test was used to compare the baseline characteristics of the children who were lost at 1-year follow-up with those who remained in the study. In addition, it was applied to compare the percentage of new caries lesions and of lesions that progressed on sound occlusal sites and on sites presenting inactive enamel lesions.

At site level, a logistic regression model was applied to estimate the risk of caries incidence and progression during the study period. The dependent variable was enamel changes in terms of "caries incidence and progression" as defined in Table 1. The independent variables were the following: occlusal site status (reference: sound vs. inactive lesion), stage of eruption (reference: fully erupted vs. partially erupted), occurrence and distribution of plaque (reference: none and hardly detectable plaque vs. easily detectable plaque), type of molar (reference: first molar vs. second molar), and dental arch (reference: upper vs. lower). All independent variables were maintained in the adjusted model irrespective of their p-values. Since caries data for individual sites within the mouth of the same child are correlated, logistic regression models were fitted using generalized estimating equation (GEE) with exchangeable working correlation matrices. Data were analyzed using SPSS, version 18.0, and WinPepi software was used for Kappa calculation, version 10.5.

RESULTS

At the 1 year examination, the reliability for the diagnosis of occlusal enamel surfaces status was the following: sound surfaces 0.77 (95% CI = 0.63 - 0.91), surfaces presenting active non-cavitated and cavitated 0.81 (95% CI = 0.65 - 0.97), surfaces presenting inactive non-cavitated and cavitated lesions 0.71 (95% CI = 0.53 - 0.90). The overall non-weighted Kappa value for caries examination was 0.76 (95% CI = 0.63 - 0.89). From a total of 258 schoolchildren aged from 6 to 15 years included in the convenience sample, 200 attended the 1-year examination (drop-out rate of 22.5%, Fig. 1). Boys represented 48% of the sample (n=96) and girls 52% (n=104) with a median age of 13 years. The characteristics of the children who were lost to follow-up were compared with those of the children who remained in the study. No statistical significant differences (p>0.05) were observed in relation to age, gender, status of molars occlusal surfaces, stage of eruption of molar teeth and thick plaque accumulation on occlusal surfaces of molar teeth. The number of fully erupted second molars were significantly higher in children who were lost of follow-up than in children who remained in the study (p=0.03).

Most children (87%) had from 4 to 8 molars (median 6) evaluated during the study period. A total of 533 molars with sound occlusal surfaces and 539 molars with inactive occlusal enamel lesions were included in the sample. Permanent first molars accounted for 620 (58%) and second molars for 452 (42%) of the teeth included similarly distributed in maxilla and mandible.

After 1 year, there was no change in status of the molar teeth of 89.0% of the children who were assembled in the category “no changes”. Eleven percent of the children (n=22) were assembled in the category “progression” characterized by the presence of at least one active lesion at the follow-up examination on a site classified as sound or with inactive enamel lesion at the baseline examination. The active lesion could be clinically identified either in enamel or in dentin. Caries progression was also assumed when the surface was filled at the follow-up examination. None of the molars had been crowned or extracted.

The distribution of enamel changes at site level during the study period is shown in Table 2. No significant difference was observed in terms of caries incidence and progression between sound sites and sites with inactive occlusal enamel lesions (χ^2 Test, p=0.48). A comparison of caries progression between sound occlusal site and occlusal site with inactive enamel lesion of first and second permanent molars did not show a significant difference (χ^2 test, p=0.07).

Table 3 shows the results of the regression analysis of biological factors for prediction of caries incidence and progression on occlusal surfaces during the study period. Adjusted for plaque, stage of eruption, type of molar and dental arch, inactive enamel lesions presented a similar risk for caries progression than sound occlusal surfaces (OR=0.98, 95%CI=0.40-2.38). The presence of easily detectable plaque on occlusal sites was the only predictor for caries incidence and progression after 1 year (OR=2.73: 95% CI 1.01-7.41; $p<0.05$).

DISCUSSION

The present study gathered evidence about the 1 year outcome of inactive occlusal enamel lesions in children and adolescents with regular access to fluoride and low caries prevalence. The most important findings were the high number of children (89%) who remained caries inactive as well as the number of sites on occlusal surfaces with inactive enamel lesions (96.8%) that remained inactive at the 1 year follow-up examination.

The findings of our study were in line with previous clinical trials in low caries prevalence children (57% caries-free at the age of 5-6) participating in a treatment program to control caries in erupting molars (1, 13). After 1 and 3 years, 80-90% of the sites of the groove-fossa-system showed no enamel changes or regression of lesions. In these trials, the methodology of mapping enamel changes on the groove-fossa-system proved to be an effective means of ensuring an accurate identification of individual lesions on occlusal surfaces in follow-up examinations. Hence, it was always possible to make a distinction between a sound site and a site with inactive lesion at the baseline examination that had developed an active lesion, non-cavitated or cavitated, or that was filled at the follow-up examination (1, 13).

Mapping the groove-fossa-system was a relevant aspect of our study that allowed accurate outcomes concerning caries incidence, progression and risk on sound sites and sites with inactive enamel lesions. Our results are also corroborated by the 2 years treatment program for occlusal caries control in high caries prevalence children (21% caries-free at the age of 5-6) which resulted in 84% of the occlusal surfaces with no enamel changes or regression of lesions at the end of the study (14). More recently, the fate of inactive occlusal lesions was reported in the literature by two other long-term evaluation studies (4, 19). The study by Nyvad et al. [2003] was carried out in adolescents with high caries prevalence who completed a three-year fluoride clinical trial. The authors reported that at the end of the study 90% of the surfaces had no caries progression. However, caries progression on sound occlusal surfaces (5%) was markedly different from occlusal surfaces presenting inactive enamel lesions (30%). Additionally, inactive occlusal enamel lesions entailed a considerably greater risk of progressing to a cavity than sound surfaces (RR= 5.34; CI 3.5-8.1). The study by Ferreira Zandoná et al. [2012] was also carried out in high risk rural population of children and adolescents aged 5 to 13 years. Only 6% of sound occlusal surfaces in contrast to 51% of surfaces with inactive enamel lesions, non-cavitated and cavitated, progressed within 2 years of observation. The results of both studies are in contrast with the present one and further consideration is therefore warranted. First of all, in our study, progression of inactive enamel lesions was monitored at site level whereas in the other studies it was monitored at surface level. Secondly, our results concern a 1-year evaluation whereas the above mentioned studies described the results of 3 and 2 years, respectively. The clinical implication of monitoring at surface level is that an overestimation of the number of inactive lesions progressing to active lesions cannot be ruled out. The presence of sites with active lesions at follow-up examinations does not necessarily mean progression of inactive lesions as it can also be a consequence of sound sites becoming caries active on the same occlusal surface. Moreover, our analysis of risk factors did not identify inactive occlusal enamel lesions as having greater risk of progressing to a cavity than sound surfaces (OR=0.98; CI=0.40-2.38; p=0.96) as previously reported (4). Further results of two and three year follow-up of the present study will help clarify the differences between longitudinal studies dealing with the fate of inactive lesions.

Recently, the relevance of the identification, the analysis and the adjustment of biologically plausible and non plausible regression of caries lesions in longitudinal clinical trials was brought in evidence (20). In our study, the criteria applied to identify changes in terms of lesion activity during the study period did not consider any regression at individual or site levels. This is explained by the fact that at the commencement of the trial all occlusal surfaces sites were either sound or with inactive lesion and that at 1 year follow-up examination clinical status of both sites were equally considered not compatible with mineral loss.

One may argue that using the same examiner for the baseline and 1 year follow-up examinations should account for its limitations as the examiner was aware that all children were caries-inactive at the beginning of the study. We acknowledge this limitation, but the examiner was blinded with respect to the baseline mapping and recording of surface status at 1 year follow-up examination. Additionally, the reliability of caries diagnosis according to lesion activity showed kappa value of at least 0.71.

The attrition of 22.5% was a limitation of this study. However, no significant difference ($p>0.05$) was found between the biological characteristics of the children who were lost to follow-up and those who remained in the study that could reduce the risk of caries progression in the latter group. The analysis of biological determinants (1, 13, 14, 17, 21) that could predict caries incidence and progression on occlusal surfaces indicated that the presence of easily detectable plaque on occlusal sites was the only predictor for caries incidence and progression after 1 year ($p<0.05$). The risk of caries incidence and progression between erupting and fully erupted molars was not significant (OR=1.74, $p=0.25$). These results may be due to the fact that changes in plaque scores have not occurred in the same magnitude as the changes in the stage of eruption over the study period. Fifty point eight percent of the teeth showing visible plaque at baseline still presented visible plaque at the 1-year examination (148 out of 291) while 81.2% of partially erupted molars at baseline reached full occlusion in the same period of observation (121 out of 149) (data not shown).

Since no difference was observed in caries incidence, progression and risk on sound occlusal sites in comparison with sites presenting inactive enamel lesions, the null hypothesis was accepted. In conclusion, our findings add to the current knowledge about treatment decisions relating to caries-inactive children and adolescents with regular access to fluoride and low caries prevalence. It suggests that occlusal surfaces harboring inactive caries lesions do not require additional attention than the one normally given to sound occlusal surfaces over a 12-months period.

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FIGURE 1

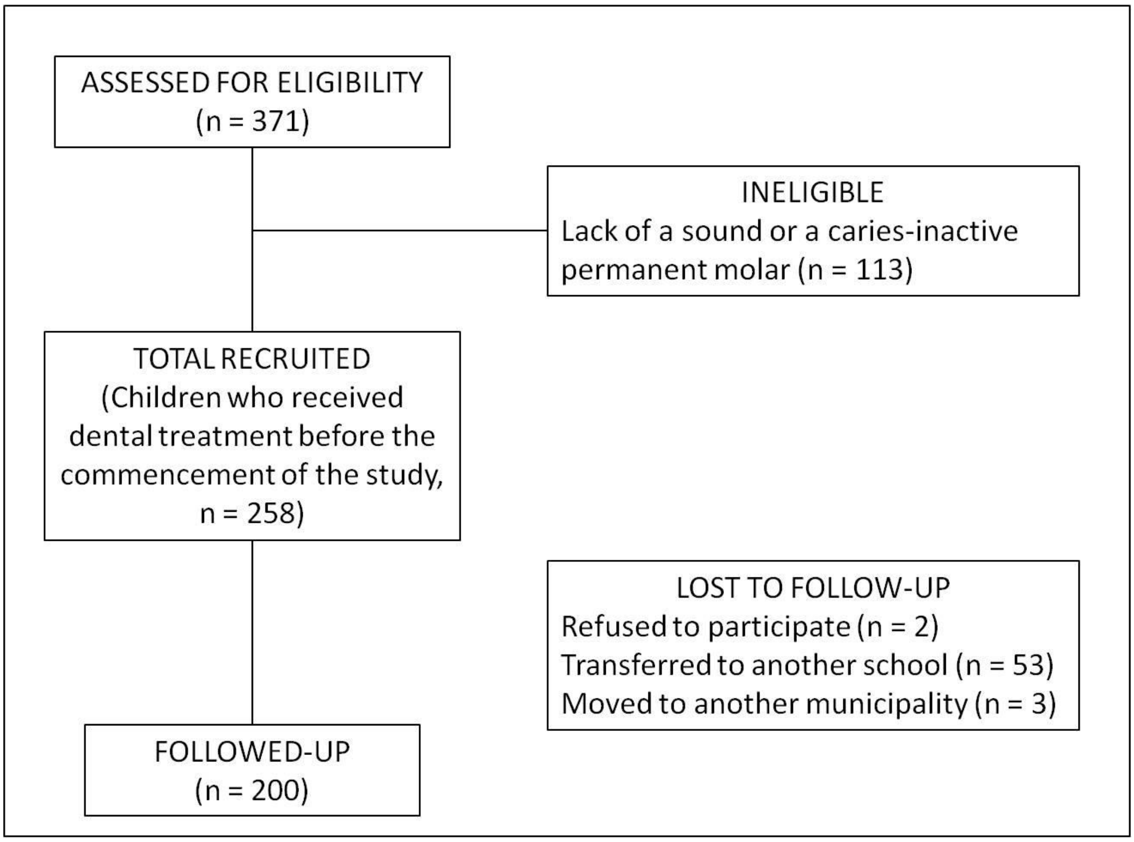

Figure 1 – Flow chart of the study.

TABLE 1

Table 1 – Criteria used for classification of enamel changes in terms of activity during the study period.

Baseline	After 1 year	Outcome
Sound	Sound	No change
Sound	Inactive enamel lesion	
Inactive enamel lesion	Inactive enamel lesion	
Inactive enamel lesion	Sound surface	
Sound	Active lesion	Progression
Inactive enamel lesion	Active lesion	

Adapted from Carvalho et al. (1992).

TABLE 2

Table 2 – Distribution and comparison of enamel changes during the study period on sound occlusal sites and on sites presenting inactive enamel lesions.

Baseline	**After 1 year**			
Site status	No changes	Progression		Total
		Active lesion	Filled	
Sound	519 (97.4%)	10 (1.9%)	4 (0.7%)	533 (49.7%)
Inactive enamel lesion	518 (96.1%)	16 (3%)	5 (0.9%)	539 (50.3%)
Total	1,037 (96.8%)	26 (2.4%)	9 (0.8%)	1,072 (100%)

p=0.48 (χ^2 test)

TABLE 3

Table 3 – Biological factors for prediction of caries progression on occlusal surfaces (adjusted model).

Variable	N (%)	OR	95% CI	p
Site status				
Sound	533 (49.7)	1.00		
Inactive	539 (50.3)	0.98	0.40- 2.38	0.96
Plaque				
No + hardly visible	874 (81.5)	1.00		
Easily visible	198 (18.5)	2.73	1.01-7.41	0.04
Eruption				
Fully	923 (86.1)	1.00		
Partially	149 (13.9)	1.74	0.67-4.52	0.25
Type of molar				
First	620 (57.8)	1.00		
Second	452 (42.2)	1.13	0.41-3.09	0.81
Arch				
Upper	567 (52.9)	1.00		
Lower	505 (47.1)	1.13	0.5 -2.52	0.76

OR = Odds ratio obtained in a logistic regression model based on generalized estimating equations; CI = Confidence Interval.

CONSIDERAÇÕES FINAIS

Com a significativa redução da prevalência e severidade da cárie dentária observada nas últimas décadas, a atenção tanto do profissional quanto da pesquisa clínica tem se voltado para o diagnóstico e manejo das lesões cariosas não cavitadas.

O presente estudo demonstrou uma associação significativa entre o estágio eruptivo de molares permanentes e atividade de cárie. A magnitude do efeito observada, a presença de gradiente biológico (com o risco diminuindo à medida que o estágio eruptivo aumenta), e a plausibilidade biológica evidenciam a natureza causal da associação encontrada (HILL, 1965). Com base nestes resultados, o período eruptivo de molares permanentes pode ser visto como um momento de risco aumentado para o desenvolvimento de lesões cariosas. Este fato deve ser considerado pelos profissionais da odontologia ao procederem o diagnóstico e o planejamento da abordagem terapêutica para o controle da cárie dentária em crianças e adolescentes.

Ao acompanhar longitudinalmente lesões cariosas inativas em superfícies oclusais de molares permanentes e compará-las com superfícies hígidas, observou-se uma pequena proporção de migração para lesões ativas ou restaurações ao longo de 12 meses. Apenas 3,9% das lesões cariosas inativas e 2,6% das superfícies hígidas apresentaram-se na condição de ativas ao final do período observacional. Na análise avaliando o risco de incidência/progressão, não foi observada diferença entre as lesões cariosas inativas e as superfícies hígidas. Tendo em vista a baixa taxa de progressão observada nas lesões cariosas inativas durante o período de acompanhamento, estes achados demonstram que esta população não seria beneficiada com consultas de acompanhamento em períodos inferiores a 12 meses. O acompanhamento das lesões inativas por períodos de tempo maiores é importante para a definição das taxas de progressão em longo prazo.

É importante salientar que a população em estudo nesta tese apresenta acesso regular a produtos fluoretados e baixa experiência de cárie. Sendo assim, a extrapolação dos resultados obtidos para outras populações com maior experiência de doença deve ser feita com cautela.

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ANEXOS

MINISTÉRIO DA SAÚDE Conselho Nacional de Saúde Comissão Nacional de Ética em Pesquisa (CONEP)	UNIVERSIDADE FEDERAL DE SANTA MARIA Pró-Reitoria de Pós-Graduação e Pesquisa Comitê de Ética em Pesquisa - CEP- UFSM REGISTRO CONEP: 243

CARTA DE APROVAÇÃO

O Comitê de Ética em Pesquisa – UFSM, reconhecido pela Comissão Nacional de Ética em Pesquisa – (CONEP/MS) analisou o protocolo de pesquisa:

Título: Diagnóstico e tratamento não invasivo de lesões cariosas; avaliação longitudinal após validação de métodos de diagnóstico visuais
Número do processo: 23081.008528/2008-35
CAAE (Certificado de Apresentação para Apreciação Ética): 0097.0.243.000-08
Pesquisador Responsável: Julio Eduardo do Amaral Zenkner

Este projeto foi APROVADO em seus aspectos éticos e metodológicos de acordo com as Diretrizes estabelecidas na Resolução 196/96 e complementares do Conselho Nacional de Saúde. Toda e qualquer alteração do Projeto, assim como os eventos adversos graves, deverão ser comunicados imediatamente a este Comitê. O pesquisador deve apresentar ao CEP:

Abril/2009 **Relatório final**

Os membros do CEP-UFSM não participaram do processo de avaliação dos projetos onde constam como pesquisadores.

DATA DA REUNIÃO DE APROVAÇÃO: 12/08/2008

Santa Maria, 13 de Agosto de 2008.

Lissandra Dal Lago
Coordenadora do Comitê de Ética em Pesquisa – UFSM
Registro CONEP N. 243.

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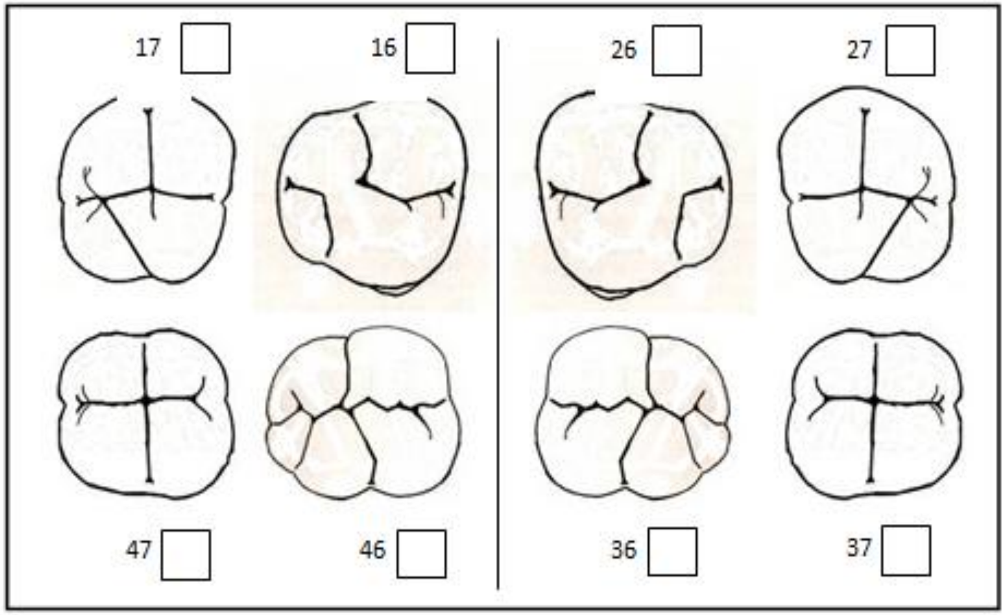
UNIVERSIDADE FEDERAL DE SANTA MARIA
DEPARTAMENTO DE ESTOMATOLOGIA
DISCIPLINA DE ODONTOLOGIA EM SAUDE COLETIVA

EXAME CLÍNICO DO BIOFILME DENTÁRIO

PACIENTE Nº.: _______ DATA ____/____/____ EXAME: Inicial ☐ 12 meses ☐ 24 meses ☐ 36 meses ☐
NOME: ________________ ENDEREÇO: ________________ FONES: ________
PAIS / RESP: ________________ OUTRO CONTATO: ________________ FONES: ________



UNIVERSIDADE FEDERAL DE SANTA MARIA
DEPARTAMENTO DE ESTOMATOLOGIA
DISCIPLINA DE ODONTOLOGIA EM SAUDE COLETIVA

EXAMES CLÍNICO (ICDAS II) E RADIOGRÁFICO DAS LESÕES OCLUSAIS

PACIENTE Nº.: _______ DATA ____/____/____ EXAME: Inicial ☐ 12 meses ☐ 24 meses ☐ 36 meses ☐

NOME: ______________________________ ENDEREÇO: ______________________________________ FONES: ______________

PAIS / RESP: _____________________________ OUTRO CONTATO: ______________________________ FONES: ______________

Dente	ICDAS	Ativ.	Erup	Rx
17				
16				
27				
26				
37				
36				
47				
46