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Review article

The effect of resin infiltration on proximal caries lesions in primary and permanent teeth. A systematic review and meta-analysis of clinical trials

Sofia Chatzimarkou[a], Despina Koletsi[b,c,d,*], Katerina Kavvadia[a]

[a] Department of Paediatric Dentistry, School of Dentistry, National and Kapodistrian University of Athens, Athens, Greece
[b] Clinic of Orthodontics and Paediatric Dentistry, Center of Dental Medicine, University of Zurich, Zurich, Switzerland
[c] Department of Orthodontics, School of Dentistry, National and Kapodistrian University of Athens, Athens, Greece
[d] Private Practice, Athens, Greece

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ABSTRACT

Introduction/objectives: This systematic review aimed to critically appraise the evidence on resin infiltration for the clinical management of proximal caries lesions in primary and permanent teeth.
Data: Search terms included resin infiltration, micro-invasive and proximal caries. Potentially eligible studies involved proximal caries lesions treated with resin infiltration. Risk of bias assessment was performed using the Cochrane risk of bias tool and the quality of evidence was assessed with GRADE.
Sources: Electronic Database search of published and unpublished literature was performed in April 22, 2018 within the following databases: MEDLINE via Pubmed, Cochrane Central Register of Controlled Trials, LILACS via BIREME, Open Grey, Clinical Trials.gov and National Research Register.
Study selection: Of 135 articles initially retrieved, 10 were eligible for inclusion in the systematic review comprising the results of 9 studies, while 5 randomized controlled trials (RCTs) (6 articles) with unclear risk of bias contributed to the meta-analyses. Random effects meta-analyses were implemented and lesion progression treatment effects were estimated through Odds Ratios (ORs) along with associated 95% Confidence Intervals (95% CIs).
Conclusions: Overall, there was strong evidence that proximal caries lesion progression was less likely to occur in permanent teeth following treatment with resin infiltration plus oral hygiene measures as compared to non-invasive methods (oral hygiene instructions) for follow up 18 months to 2 years (3 studies: OR = 0.14; 95% CI: 0.08, 0.25; P < 0.001) as well as 3 years (4 studies: OR = 0.15; 95% CI: 0.06, 0.36; P < 0.001). The quality of the evidence was rated as moderate to low respectively.

Clinical significance

Halting the progress of interproximal non cavitated lesions confined up to 1/3 of the dentin, is of considerable importance for caries management. The synthesis of the available evidence provides useful insights to promote clinical decision making based on optimal clinical practices.

1. Introduction

While there has been a dramatic reduction in caries prevalence for occlusal surfaces, only a meager decline has taken place for proximal surfaces [1]. Proximal caries may comprise more than half of all reported caries [2]. In primary molars, the percentage of proximal caries lesions may be higher, varying from 30 to 75% [3–5]. The progression of interproximal caries from early decalcification to cavitation has been of great interest for its clinical implications because if detected early before cavitation level, caries can be managed with preventive protocols or micro invasive interventions [6]. Cavitation is considered by most as the threshold to institute operative treatment, the higher the lesion's ICDAS category, the higher the chance for the proximal surface to be cavitated [7]. Furthermore, the progression of the lesion is related to the baseline ICDAS lesion severity [8], the more intact surfaces being more resistant to caries progression [9]. Therefore, intervention to preserve demineralized enamel in non cavitated lesions and halt any progression, would be a rather beneficial caries management approach, both for primary and permanent teeth, in order to prevent subsequent restoration.

Customarily, interproximal lesions have been treated using ordinary invasive restorative (drill and fill) methods [10]. The restorative

* Correspondence to: 5 Kanari Street, 15127 Melissia, Attica, Greece.
E-mail address: d.koletsi@gmail.com (D. Koletsi).

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approach involves the removal of sound tooth structure along with the removal of the carious tissues [11]. The durability of restorations is limited and the initial invasive intervention often brings the tooth into a circle of treatment and re-treatment, known as the 'death spiral of restorations' [12]. Consequently, noninvasive measures have been developed with promising results on halting the lesion progression. These measures include oral hygiene intensified protocols by mechanical removal of plaque with flossing or interdental brushing, dietary advice, chemical control of cariogenic bacterial load by in office application of chlorhexidine varnishes, or re-mineralizing treatments with in- office topical fluoride or home use of casein phosphopeptide [13–15]. However, the effectiveness of the above measures may be compromised by poor patient compliance and recall visits treatment costs [16–21].

Thus, micro-invasive approaches where introduced as alternative to preventive measures for the management of non cavitated proximal carious lesions, up to the outer third of dentin, being independent to patient compliance and more conservative than standard invasive restorative approaches. Such micro-invasive methods already used are polyurethane foils [22], low viscosity composite resins and dental adhesives [23–26] and sealants [27]. Their success rate however is not as promising since despite their potential to form a resin layer on the tooth surface, the penetration of porous decalcified enamel is superficial [28]. Hence, another concept, namely caries infiltration was introduced as a proximal micro-invasive treatment approach, aiming in infiltrating the porous body of the lesion as well as establishing a diffusion barrier within the tooth. Diffusion pathways for cariogenic acids and dissolved minerals are occluded, thus halting the demineralization process before it has reached cavitation [29]. The concept of caries infiltration was first developed at the Charité Berlin as a micro-invasive approach for the management of smooth surface and proximal non-cavitated caries lesion [30]. It is marketed under the name Icon (DMG America Company, Englewood, NJ). Caries infiltration utilizes capillary forces to carry methacrylic resins with high penetration coefficients (infiltrants) into the porous enamel. Enamel is etched using HCl 15% rather than phosphoric acid to remove the pseudo-intact surface layer [31].

Resin infiltration is a promising technique that could reduce the loss of dental hard tissue and avert costly treatments. Furthermore, resin infiltration depends less on patient's compliance thus providing increased efficacy. However there is still uncertainty about the technique's success as compared to standard invasive and non-invasive preventive treatments. Previous systematic reviews [32,33], have shown promising results considering the use of resin infiltration technique for interproximal early caries, however, the need to assess the latest evidence provided by the most recent clinical trials as well as to conduct a quantitative synthesis of the current data, indicated the need for the present systematic review. Therefore, the objective of this review was to provide a comprehensive synthesis of resin infiltration effect in vivo, on early proximal caries lesions in the primary and permanent teeth.

2. Material and methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [34,35] were followed for reporting of this systematic review.

2.1. Eligibility criteria

The following inclusion/exclusion criteria were applied for this systematic review:

- Study design: Randomized Controlled Trials (RCTs) or Controlled Clinical Trials (CCTs) were considered. Both parallel and split-mouth designs were eligible.
- Participants: Patients (children and/or adults) in primary or mixed/ permanent dentition with proximal caries lesions, extending at enamel to the outer third of dentin.
- Intervention: Resin Infiltration (with or without non-invasive methods such as dental floss, fluoride).
- Comparator: Other micro-invasive treatment technique or non-invasive methods (control) such as dental floss, fluoride.
- Outcome measures: Lesion progression after application of treatment (assessed with any type of radiographic or clinical measure).
- Exclusion Criteria: Studies involving patients with systematic or other diseases, patients undergoing orthodontic treatment, lesions other than proximal (i.e. Labial/lingual surface lesions).

2.2. Search strategy

Electronic search within the following databases was undertaken in September 30, 2017 and updated in April 22, 2018, while no language restrictions were applied: Medline via Pubmed, Cochrane Central Register of Controlled Trials (CENTRAL), LILACS via BIREME Virtual Health Library. Moreover, unpublished literature was searched in Open Grey, ClinicalTrials.gov (www.clinicaltrials.gov) and the National Research Register (www.controlled-trials.com), using the terms (resin infiltration) AND (proximal lesion). Hand searching of the reference lists of the retrieved full text articles was also conducted. Authors of original studies were contacted for data clarification if needed. Full search strategy employed in Medline via Pubmed is presented in Appendix A.

Eligibility assessment, data extraction and Risk of Bias (RoB) assessment was implemented independently and in duplicate by two reviewers (SC and DK), while disagreements were resolved through discussion and after consultation with a third author (KK).

2.3. Data extraction

Data extraction was performed by two independently working reviewers (SC and DK) on standardised piloted forms who were not blinded to author identity and study origin. Titles and abstracts were examined first, followed by full text screening of the potential for inclusion articles. Information was obtained from each eligible study on study design, methods, participants, interventions, comparators and outcomes, observation period and adverse effects.

2.4. Risk of bias within studies

Risk of bias in individual studies was assessed according to the Cochrane Risk of Bias tool [36]. In particular, the following domains were considered: 1. random sequence generation, 2. allocation concealment, 3. blinding of participants and/ or personnel involved in the study, 4. blinding of assessors, 5. incomplete outcome data reporting, 6. selective reporting of outcomes, 7. other sources of bias (including industry related bias or professional interest). An overall assessment of the risk of bias was made for each included study (high, unclear, and low). Trials with at least 1 item designated to be at high risk of bias were regarded as having an overall high risk of bias. Trials with unclear risk of bias for one or more key domains were considered to be at unclear risk of bias and trials with low risk of bias in all domains were rated as low risk of bias.

2.5. Summary measures and data synthesis

Clinical heterogeneity of included studies was assessed through the examination of individual trial settings, eligibility criteria, treatment methods used and data collection methods. Statistical heterogeneity was examined through visual inspection of the confidence intervals (CIs) for the estimated treatment effects on forest plots. Also, a chi-square test was applied to assess heterogeneity; a p-value below the level of 10% ($p < 0.1$) was considered indicative of significant heterogeneity [37]. I^2 test for homogeneity was also undertaken to quantify the extent of heterogeneity.