Evidence-based Update of Pediatric Dental Restorative Procedures: Preventive Strategies

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Background: *There has been significant advances in the understanding of preventive restorative procedures regarding the advantages and disadvantages for restorative procedures; the evidence for conservative techniques for deep carious lesions; the effectiveness of pit and fissure sealants; and the evidence for use of resin infiltration techniques. Aim: The intent of this review is to help practitioners use evidence to make decisions regarding preventive restorative dentistry in children and young adolescents.*
Study Design: *This evidence-based review appraises the literature, primarily between the years 1995-2013, on preventive restorative strategies. The evidence was graded as to strong evidence, evidence in favor, or expert opinion by consensus of authors* ***Results:*** *The preventive strategy for dental caries includes individualized assessment of disease progression and management with appropriate preventive and restorative therapy. There is strong evidence that restoration of teeth with incomplete caries excavation results in fewer signs and symptoms of pulpal disease than complete excavation. There is strong evidence that sealants should be placed on pit and fissure surfaces judged to be at risk for dental caries, and surfaces that already exhibit incipient, non-cavitated carious lesions. There is evidence in favor for resin infiltration to improve the clinical appearance of white spot lesions.* ***Conclusions:*** *Substantial evidence exists in the literature regarding the value of preventive dental restorative procedures.*

Key words: pediatric dentistry, preventive dentistry, evidence-based dentistry, dental materials.

INTRODUCTION

There have been considerable advances in our understanding of preventive restorative procedures. This article contains systematic reviews and clinical trials, generally published between the years 1995-2013, regarding the advantages and disadvantages for restorative procedures; evidence for conservative restorative techniques for deep carious lesions; substantiation of effectiveness of pit and fissure sealants; and evidence for use of resin infiltration techniques. The intent of this review is to help practitioners use evidence to make decisions regarding preventive restorative dentistry in children and young adolescents.

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MATERIALS AND METHOD

A thorough review of the scientific literature in the English language, between the years 1995-2013, pertaining to preventive restorative dentistry in primary and young permanent teeth was accomplished using electronic database and hand searches, with the terms: "Restorative treatment decisions, caries diagnosis, caries excavation, pit and fissure sealants, and resin infiltration."

Papers identified were initially classified as meta-analysis/ systematic reviews, or prospective clinical trials of the above topics . Initial criteria used to evaluate clinical trials included studies in children or adults; interventions with control groups; and outcomes of more than one year. For each topic the studies initially were evaluated by two individuals using the published abstracts of the articles. Those studies that met the initial screening received full evaluation and abstraction that included detailed examination of the research methods and potential for study bias (e.g., appropriateness of the control group(s); issues with patient recruitment, randomization, blinding, subject loss, sample size estimates, conflicts of interest, and statistics). Studies that did not meet the standards of a randomized clinical trial or were believed to have high bias were eliminated. In those topic areas in which there were rigorous meta-analyses or systematic reviews available, only those clinical trial articles that were not covered by the reviews were subjected to full evaluation and abstraction.

The assessment of evidence for each topic was based on grading of recommendations as: strong evidence (based on well executed randomized control trials, meta-analyses, or systematic reviews); evidence in favor (based on weaker evidence from clinical trials); and expert opinion (based on retrospective trials, case reports, in vitro studies and opinions from clinical researchers) [1].

RESULTS AND DISCUSSION

This strategy yielded 3 meta-analyses/systemic reviews for the topic of "when to restore", two meta-analyses/systemic reviews and nine randomized clinical trials for "deep caries excavation and restoration"; ten meta-analyses/systemic reviews and three randomized control trials for "pit and fissure sealants"; and two systematic reviews and three randomized clinical trials for "resin infiltration" that primarily made up the evidence for this review.

When to Restore

Historically, the management of dental caries was based on the belief that it was a progressive disease that eventually destroyed the tooth unless there was surgical and restorative intervention [2]. It is now recognized that restorative treatment of dental caries alone does not stop the disease process[3] and restorations have a finite lifespan. Conversely, some carious lesions may not progress, and therefore may not need restoration. Therefore, contemporary management of dental caries includes identification of an individual's risk for caries progression, understanding of the disease process for that individual, and "active surveillance" to assess disease progression and manage with appropriate preventive services, supplemented by restorative therapy when indicated[4].

With the exception of reports of dental examiners in clinical trials, studies of reliability and reproducibility of detecting dental caries are not conclusive [5]. There also is minimal information regarding validity of caries diagnosis in primary teeth [2], as primary teeth may require different criteria due to thinner enamel and dentin and broader proximal contacts[6]. Furthermore, indications for restorative therapy only have been examined superficially because such decisions have generally been regarded as a function of "clinical judgment" [7]. Decisions for when to restore carious lesions, at least, should include clinical criteria of visual detection of enamel cavitation, visual identification of shadowing of the enamel, and/or radiographic recognition of enlargement of lesions over time [4,8,9].

The benefits of restorative therapy include: removing of cavitations or defects to eliminate areas that are susceptible to caries; stopping the progression of tooth demineralization; restoring the integrity of tooth structure; preventing the spread of infection into the dental pulp; and preventing the shifting of teeth due to loss of tooth structure. The risks of restorative therapy include lessening the longevity of teeth by making them more susceptible to fracture, recurrent lesions, restoration failure, pulp exposure during caries excavation, future pulpal complications, and iatrogenic damage to adjacent teeth [10,11,12]. Primary teeth may be more susceptible to restoration failures than permanent teeth [13]. Additionally, before restoration of primary teeth, one needs to consider the remaining length of time prior to tooth exfoliation.

In summary, the management of dental caries includes the identification of an individual's caries risk, understanding of the disease process for that individual, and "active surveillance" to assess disease progression and manage with appropriate preventive services, supplemented by restorative therapy when indicated. There is expert opinion regarding decisions for restoration of carious lesions, at least, should include clinical criteria of visual detection of enamel cavitation, visual identification of shadowing of the enamel, and/or radiographic recognition of enlargement of lesions over time.

Deep Caries Excavation and Restoration

Among the objectives of restorative treatment are to repair or limit the damage from caries, protect and preserve the tooth structure, and maintain pulp vitality whenever possible. The American Academy of Pediatric Dentistry Guideline on pulp therapy for primary and immature permanent teeth states the treatment objective for a tooth affected by caries is to maintain pulpal vitality, especially in immature permanent teeth for continued apexogenesis [14].

With regard to the treatment of deep caries, three methods of caries removal have been compared to complete excavation, that is where all carious dentin is removed. Stepwise excavation is a two-step caries removal process where at the first appointment carious dentin is partially removed leaving caries over the pulp and placing a temporary filling. At the second appointment, all remaining carious dentin is removed and a final restoration placed [15]. Partial, or one-step, caries excavation removes part of the carious dentin, but leaves caries over the pulp, and subsequently places a base and final restoration [16,17]. No removal of caries before restoration of primary molars in children aged 3 to 10 years has also been reported [18]

There is evidence in primary and permanent teeth from randomized controlled trials and a systematic review showing that pulp exposures are significantly reduced using incomplete caries excavation compared to complete excavation in teeth that has a normal pulp or reversible pulpitis. Two trials and a Cochrane review found that partial excavation resulted in significantly less pulp exposures compared to complete excavation [19,20,21]. Two trials of step-wise excavation showed that pulp exposure occurred more frequently from complete excavation compared to stepwise excavation [15,20]. There also is evidence of a decrease in pulpal complications and post-operative pain after incomplete caries compared to complete excavation in clinical trials [15,20,22,23], and summarized in a meta-analysis [24].

Additionally, a meta-analysis found the risk for permanent restoration failure was similar for incompletely compared to completely excavated teeth [24]. With regard to the need to reopen a tooth with partial excavation of caries, one randomized controlled trial that compared partial (one step) to stepwise excavation in permanent molars found higher rates of success in maintaining pulp vitality with partial excavation, suggesting there is no need to reopen the cavity and perform a second excavation [16]. Interestingly, two randomized controlled trials suggest that no excavation can arrest dental caries so long as a good seal of the final restoration is maintained [18,25].

In summary, there is strong evidence that incomplete caries excavation in primary and permanent teeth, with normal pulps or reversible pulpitis, results in fewer pulp exposures and fewer signs and symptoms of pulpal disease than complete excavation. There also is evidence in favor that partial excavation (one step) followed by placement of final restoration leads to higher success in maintaining pulp vitality in permanent teeth than stepwise (two-step) excavation.

Pit and Fissure Sealants

Pit and fissure caries account for approximately 80-90% of all caries in permanent posterior teeth and 44% in primary teeth [9]. Pit and fissure sealant has been described as a material placed into the pits and fissures of caries-susceptible teeth that micromechanically

bonds to the tooth preventing access by cariogenic bacteria to their source of nutrients [27], thus reducing the risk of caries and caries progression in those susceptible pits and fissures.

With regard to evidence of effectiveness, a Cochrane review found that sealants placed on the occlusal surfaces of permanent molars in children and adolescents reduces caries up to 48 months when compared to no sealant [28]. According to a meta-analysis of 24 studies, the overall effectiveness of autopolymerised fissure sealants in preventing dental decay was 71% [29]. Another Cochrane review calculated that placement of resin-based sealant in children and adolescent reduces caries incidence to 86% after 1 year and 57% at 48 to 54 months [30]. Sealants must be retained on the tooth and should be monitored to be most effective. Studies incorporating recall and maintenance have reported resin-based sealant success levels of 80% to 90% after 10 or more years [31,32].

There are many systematic reviews and clinical trials regarding optimizing the effectiveness of dental sealants. Sealants are more cost-effective in children with caries risk and are generally recommended to be placed only in those children at caries risk [4,9,26]. The best evaluation of high caries risk is done by an experienced clinician using indicators of low socio-economic status, high frequency of sugar consumption, prior caries, active white spot lesions and enamel defects and low salivary flow [4].

Pit and fissure sealants lower the number of viable bacteria, including Streptococcus mutans and lactobacilli, by at least 100-fold and reduced the number of lesions with any viable bacteria by about 50 percent [33]. This evidence supports recommendations to seal sound surfaces and non-cavitated enamel lesions [9,34].

Evidence-based reviews have found that caries risk for sealed teeth that have lost some or all sealant does not exceed the caries risk for never-sealed teeth [35]. Therefore, it has been recommended to provide sealants to children even if follow-up cannot be ensured [34].

There are systematic reviews and clinical trials that have evaluated techniques for placement of sealants. According to a systematic review, isolation of the tooth is an important aspect of sealant placement and use of rubber dam improves the retention rates of light-cured resin based sealants [36]. Moisture control systems (Isolite, VacuEjector) produce sealant retention rates comparable to cotton roll isolation or rubber dam, while decreasing procedure time [37,38]. Another systematic review has shown that four-handed technique has been associated with higher retention of resin based sealants [39]. Two systematic reviews have shown that teeth cleaned prior to sealant application with a tooth brush prophylaxis exhibited similar or higher success rate compared to those sealed after hand‑piece prophylaxis [39,40]. Additionally, there is limited and conflicting evidence to support mechanical preparation with a bur prior to sealant placement and is not recommended [9]. There is evidence that mechanical preparation may make a tooth more prone to caries in case of resin-based sealant loss [41].

With regard to primer placement before sealant application, there is one randomized clinical trial that suggests that acetone or ethanol solvent based primers, especially the single bottle system, enhanced the retention of sealants, whereas water-based primers were found to drastically reduce the retention of sealants [42]. With regard to self-etch bonding agents that do not involve a separate step for etching, a systematic review found that self-etch bonding agents may not provide as good retention as acid etch technique [36]; however, one recent randomized clinical trial reported similar retention rates of self-etch system compared to acid etch group [43].

Based on a systematic review and clinical trials, there is substantial data regarding the use of resin-based and glass ionomer-based sealants. One meta-analysis and a Cochrane review show high retention rates of resin-based sealants compared to glass ionomer-based sealants [28,44]. However, glass ionomer sealants exhibited good short term retention comparable with resin sealants at one year and may be used as an interim preventive agent when resin-based sealant cannot be placed as moisture control may compromise such placement [9,28]. Another systematic review of the caries-preventive effects of glass ionomer and resin-based fissure sealants suggests no difference between these two products [45].

There is insufficient data to support use of fissure sealants in primary teeth. One trial reported retention rate of 76.5% for light polymerized fissure sealants in the follow up time of 2.8 years [46]. Another randomized clinical trial studied effectiveness of glass ionomer sealants in primary molars and found retention rate as low as 18.7% in 1.38 years and no statistically significant caries reduction [47].

In summary, there is strong evidence that sealants should be placed on pit and fissure surfaces judged to be at risk for dental caries; or surfaces that already exhibit incipient, non-cavitated carious lesions to inhibit lesion progression. There is strong evidence that sealant placement methods should include careful cleaning of the pits and fissures without mechanical tooth preparation. There also is evidence in favor that a low-viscosity hydrophilic material bonding layer, as part of or under the actual sealant, has been shown to be better for long-term retention and effectiveness. Additionally, there strong evidence that resin based materials achieve better retention and, therefore, may be preferred as dental sealants, but glass ionomer sealants could be used as transitional sealants when moisture control is not possible.

Resin Infiltration

Resin infiltration is an innovative approach to primarily arrest the progression of non-cavitated interproximal caries lesions [48,49]. The aim of the resin infiltration technique is to allow penetration of a low viscosity resin into the porous lesion body of enamel caries [48]. Most randomized clinical trials done on resin infiltration had industrial support with potential of conflict of interest. One such trial evaluated infiltration and sealants versus placebo and found significant differences between infiltration versus placebo with lesion progression 32% versus 70% respectively [50]. Another randomized clinical trial reported significant difference between infiltration (7%) versus placebo (37%) in the percentage of progression in lesion depth [48]. A systematic review on randomized clinical trials on resin infiltration rated the quality score to be low to moderate. The review concluded that resin infiltration has a potential consistent benefit in slowing the progression or reversing non-cavitated carious lesions [51].

An additional use of resin infiltration has been shown to restore white spot lesions formed during orthodontic treatment. Based on a randomized clinical trial¸ there is evidence in favor for resin infiltration to improve the clinical appearance of white spot lesions [52].

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