

## **Diamine Fluoride, Nonoperative and Restorative Approaches in Caries Management**

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### **Abstract**

This systematic review is aimed to assess of diamine fluoride, nonoperative and restorative approaches in manage the caries process in the case of early childhood caries (ECC).

Medline via PubMed was searched systematically regarding management of ECC. First priority was existing systematic reviews or randomized clinical trials otherwise cohort studies dealing with management of ECC, primarily with carious anterior teeth. After data extraction, the potential risk of bias was estimated depending on the study types, and the level of evidence was evaluated. Regarding management of ECC, results are presented for silver diamine fluoride (SDF, n = 5), nonoperative caries management (NOCM, n = 10), and restorative approaches (RA, n = 8) separately, as different kinds of studies with different levels of evidence were found for the different aspects in the management of ECC. The 5 systematic reviews on SDF showed a high potential for arrest of ECC on a high level of evidence. In NOCM, a low level of evidence for a moderate effect of fluoride varnish in arresting or remineralizing, especially non-cavitated lesions, was assessed. For RA in carious anterior upper primary teeth, a low level of evidence was found for higher failure rates of glass ionomer cement and composite fillings than composite strip crowns even if placed under general anesthesia and especially compared to other crowns (stainless steel and zirconia). In conclusions, ECC may be managed successfully with nonoperative (SDF, regular fluoride application) and moderately well with operative approaches, but the decision is affected by many other variables such as pulpal involvement, the child's cooperation or a general anaesthesia setting.

**Keywords:** *Early Childhood Caries (ECC); Diamine Fluoride; Caries Management*

### **Introduction**

Early childhood caries (ECC) is a specific form of caries that occurs in children on primary teeth. ECC is characterized as “the early onset of caries in young children with often fast progression which can finally result in complete destruction of the primary dentition” [1]. The etiology of ECC is quite clear: high sugar intake usually via a nursing bottle and insufficient or no oral hygiene, as parents do not brush or not well enough, leading to an atypical pattern of caries attack, particularly on smooth surfaces of upper anterior teeth in young children [1,2]. The epidemiological ECC classification of ECC records any carious lesions in primary teeth in children younger than 6 years [AAPD classification]. Many studies indicate that severe ECC can negatively influence the quality of life in preschool children but fortunately be

improved when treated [3]. Due to young age and often low cooperation, general anesthesia (GA) or sedation is frequently necessary for invasive dental interventions (e.g. fillings pulp therapy, extraction), going along with higher risks for the children and efforts for families and also considerable costs for the health systems [4,5]. This leads to a more complex dental decision making in how to manage ECC as not only the diagnosis of the caries lesion at the tooth level but also the caries management on the patient level needs to be considered.

Furthermore, dentists face a lot of challenges when planning operative interventions of (severe) ECC:

- The morphology of primary teeth in comparison with permanent teeth is different; as they exhibit large pulp chamber and a thinner enamel-dentin layer, which shorten the time for the caries process to reach the pulp and may cause pain and pulp complications.
- Pain and fear caused by ECC in emergency dental care can compromise future oral health-related quality of life of the child.
- Young children are immature and usually pre-cooperative (sedation or GA might be needed) and a more complex decision-making process as parents are responsible to take care for their child.
- Premature loss of anterior primary teeth may cause problems with eating/biting, difficulties in speech development and retarded eruption of permanent incisors.

Another paper in this review consortium for a consensus paper of the European Organization for Caries Research and the European Federation of Conservative Dentistry deals especially with the management of carious primary molars and different methods of removal of carious tissue and the subsequent restorations. Therefore, this topic is not included in this systematic review.

This review focuses on the management of ECC, especially carious primary (upper) anterior teeth.

### Aim of the Study

The aim of this review was to systematically evaluate the current state of knowledge on how to intervene in the caries process in carious primary (upper anterior) teeth in ECC.

### Materials and Methods

This systematic review aims to answer the following participants, interventions, comparisons and outcomes questions:

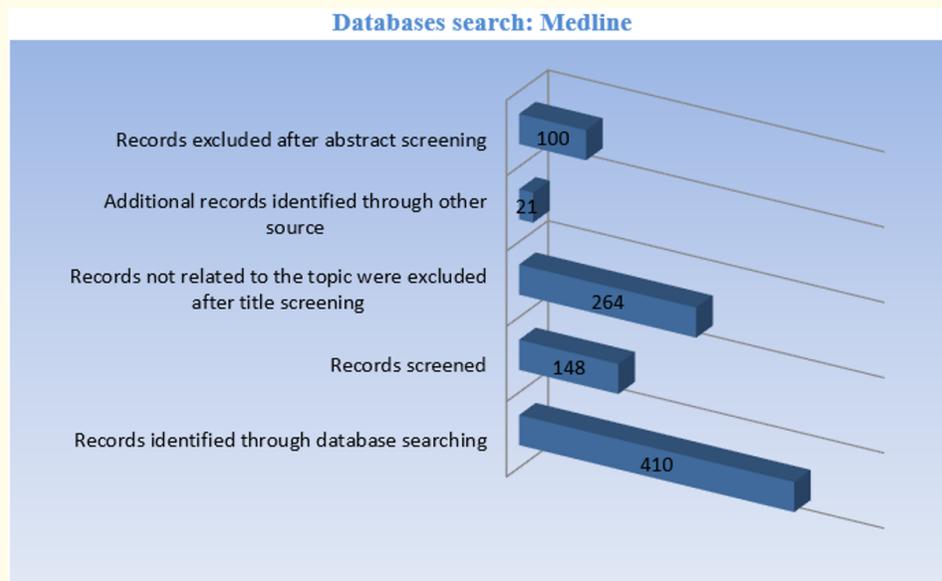
- How to intervene in the caries process in ECC (especially upper anterior teeth)?
- What is the effect of non-invasive management options on ECC?
- What are the success rates of restorative management options of ECC?

### Search strategy

Medline was searched via PubMed for appropriate papers. The used search terms and the full search strategy are shown in figure 1.

Titles and abstracts were screened to exclude papers not related to the topic. The remaining full-text articles were screened for eligibility and references hand-searched for additional sources.

The inclusion criteria were (Participants, interventions, comparisons and outcomes):



**Figure 1:** Flowchart of the systematic review on the management of ECC. ECC: Early Childhood Caries; SDF: Silver Diamine Fluoride; RCT: Randomized Controlled Trial.

- Patients: Preschool children, ECC, carious incisors, non-cavitated and cavitated (anterior) primary teeth.
- Intervention:
- Nonoperative management of carious lesions in primary (anterior) teeth with silver diamine fluoride (SDF) or any other nonoperative strategies or measures of secondary prevention.
- Restorative management of carious lesions in anterior teeth.
- Control:
- Any other nonoperative strategy (or if available restorative approach [RA]).
- Any other restorative material.
- Outcome:
- Caries or lesion progression (major failure, when necessity for pulpal therapy).
- Survival of restoration (major failure, when pain/necessity for pulpal therapy).
- Meta-analyses, systematic reviews and in case of no studies for these high evidence levels also randomized controlled trials (RCTs) and/or cohort studies (prospective and retrospective).

The exclusion criteria were:

- Permanent teeth, schoolchildren, adults
- (Vast majority of participants with ECC primary prevention)
- Caries-free primary teeth at baseline
- Only caries lesions in primary molars
- Case presentations, case series
- No clinical outcomes reported.

Information extracted from the studies included publication details, setting, participants, focused question, search results, comparators, main outcomes and conclusions.

Quality assessment depending on the type of studies, the assessed and classified the risk of bias, mostly according to the PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health-care intervention by scoring the reporting and methodological quality of the included systematic reviews.

### Outcome measures and statistical analysis

Due to the availability of a higher level of evidence for SDF (systematic reviews/meta-analyses) and the fact that in contrast to other NOCM options the effect of SDF was well examined for cavitated carious lesions, whereas other NOCM options are shown together. For SDF and other measures of NOCM, the outcome was mainly caries arrest (e.g. hardness, color, lesion size) and for RA, the main outcome was survival of restoration, that is, restorations not needing any restorative reintervention (replacement or repair).

## Results

### Management of ECC

The results are presented for SDF, NOCM and RA separately, as different kinds of studies with different levels of evidence were found for the different aspects in managing ECC on the tooth level. No RCT investigated NOCM options versus RA.

### Silver diamine fluoride

The application of SDF for ECC has been investigated in many studies. Within the selected manuscripts, there were 5 systematic reviews of which, 3 [Oliveira, *et al.* 2019 [6]; Chibinski, *et al.* 2017 [7]; Gao, *et al.* 2016 [8]] contained a meta-analysis. All of the reviews containing a total of 22 different RCTs which homogeneously show the high potential for caries arrest of SDF. The higher the concentration of SDF, the better the arrest rates, especially when applied several times, for example, biannually. SDF solution applied once or twice a year could arrest active caries lesions involving dentine with a success rate of 79 and 91%, respectively [9].

Adverse effects such as black stains were reported in studies using 38% SDF [9].

### Nonoperative caries management

Other NOCM approaches than SDF mostly employed fluoride varnish. For this subchapter, 10 studies were included: one systematic review with a part of a meta-analysis [Gao., *et al.* 2016] [8], 5 RCTs, 2 cohort studies and 2 control cohorts in SDF-RCTs [Duangthip., *et al.* 2018 [10]; Chu., *et al.* 2002 [11]]. The included studies showed that at least 63.6% [8] up to 82.2% [12] of enamel carious lesions were inactivated after fluoride varnish application. For cavitated lesions, fluoride varnish was effective in 30% of cases [10]. Sodium fluoride varnish has a moderate effect in remineralizing and/or arresting early enamel carious lesions [8,12-14] and a lower effect for cavitated carious lesions [10,15].

By brushing with fluoride toothpaste, the arrest of ECC may be achieved [16,17], but the effect is low with a low level of evidence. There is also limited evidence for efficacy of casein phosphopeptide-amorphous calcium phosphate: Daily application of 10% casein phosphopeptide-amorphous calcium phosphate paste added to regular toothbrushing with fluoride toothpaste showed no additional effect in arresting enamel caries in the primary anterior teeth [13].

### Restorative approaches

Regarding restorative options in carious anterior upper primary teeth, 8 studies were included. The level of evidence was assessed as low with a high potential of bias. In many of the studies, restorations were performed under GA. Cohort studies showed success rates of composite restorations on tooth level of 50 -90% [18]. Looking into more details, multi surface composite restorations had clearly lower retention rates (< 70%) [18].

### Quality assessment, study outcome results

The estimated risk of bias regarding systematic reviews on SDF showing moderate to low potential risk of bias Due to the diverse types of studies and RAs was used for quality assessment. Overall, considerable heterogeneity was observed in the NOCM and RAs and materials under analysis, the subject characteristics and outcome measures.

Furthermore, quality assessment scales and reporting of effect scores varied among the publications. The results of NOCM were biologically and clinically reasonable and mostly in line with each other, as no outlying heterogeneity could be assessed.

### Grading the “Body of evidence”

The level of evidence emerging from this systematic review indicates that there is high evidence to support a high effect of SDF in arresting, especially cavitated carious lesions, a low level of evidence for a moderate effect of other NOCM options of ECC, especially non-cavitated lesions, as well as a low level of evidence of moderately high and clinical relevant failure rates for restorative care.

### Discussion

ECC is highly prevalent worldwide and clearly a marker for high carries risks [19]. Therefore, it was not surprising that the literature search revealed a large number of studies, but the majority was excluded for this review as they dealt with the epidemiology or the primary prevention of ECC. On the other hand, it was surprising that the management options of ECC have not been investigated profoundly. In addition, rather rare options of posts in primary incisors have been examined in RCTs [20,21], whereas frequently performed options such as fluoride varnish and fillings (glass ionomer cement, composite) have not been compared with each other in high-quality studies.

Management of cavitated carious lesions in primary teeth of very young children could be performed with SDF, as its effectiveness in arresting the activity of carious lesions (cavitated and non-cavitated) is clearly shown.

It is easy to apply, even outside dental offices, and relatively inexpensive solutions can be used, especially when compared to restorative intervention under GA. The few but relevant drawbacks of SDF are that:

1. Not in all countries an SDF product is available or not to be used for caries management (off-label use only) and
2. The occurring black staining can result in a lower acceptability for caries management by parents/care takers.

Nonoperative management of ECC has also shown to have moderate potential to inactivate the carious process especially in enamel lesions. The process of inactivation of dentinal carious lesions occurs clearly slower and less predictable, when compared with the application of SDF.

The combination of daily tooth brushing with fluoride toothpaste at home and fluoride varnish application in office or kindergartens has the advantageous effect that healthy behaviours such as daily tooth brushing and fluoride use are trained in recall visits, which may influence conviction of parental self-efficacy, laying the responsibility of treatment of ECC into care givers hands away from the dentist (SDF or restoration). Adherence to oral hygiene instructions and diet counseling are essential in caries management on patient level and should be addressed for long-term effects. Guiding the awareness and understanding of one's responsibility are important for a potential long-term oral health in the children, making it clear that despite other management options NOCM should be obligatory for all children with ECC as an approach of secondary prevention on a child and tooth level.

RAs for the management of ECC are possible, but there was low scientific evidence to suggest that conventional composite fillings for anterior teeth are a valid surgical option in ECC. There is also insufficient information about atraumatic restorative treatment in anterior primary teeth leaving little scientific evidence for the choice of restoration [22] or a restoration at all instead of an extraction. Only in the studies where a post was used followed by a composite strip crown, higher success rates could be achieved.

The RA often masks the caries activity in the child with ECC as the restorations show a high risk of failure frequently due to secondary carious lesions. When taking moderate success rates of 50 - 90% on the tooth level even for fillings performed under optimal circumstances such as GA, these rates diminish to very low success rates on a patient level due to the usually high numbers of affected teeth in one child. GICs that are less technique sensitive and being placed in only one increment could restore and arrest active dentin carious lesions, but there was low scientific evidence to suggest GIC as material of choice for anterior primary teeth [23]. When a RA is chosen for multisurface cavities, composite strip, Crowns should be favored over fillings, but possibly veneered stainless steel crowns or prefabricated primary zirconia crowns have higher success rates [24].

For RAs due to very young age and deep carious lesions with potential pulpal involvement invasive treatment may frequently be performed under sedation or GA with all its risks, efforts and costs, which should always play a role in the individual decision-making process on how to intervene in the carious process of ECC.

### Conclusion

Measures of secondary prevention should always be applied when managing ECC. Additionally, fluoride varnish is to be suggested for non-cavitated lesions and SDF for cavitated dentine lesions without irreversible pulpal involvement, while decisions for RAs should consider patient-related risk factors and the likelihood for the necessity of sedation or GA.

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