THE BEST METHODS FOR MANAGEMENT OF PRECARIOUS CORONAL LESIONS

- **Karishma Kazim**, Hon BSc
- **Sabrina Huda**, Hon BSc
- **Vanessa Kung**, MSc, Hon BSc
- **Amir Khadivi**, BSc
- **Shu-Ming Peter Lam**, BSc
- **Vanessa Hollander**, Hon BSc
- **Mary-Ellen Polymeris**, Hon BSc
- **Sean Gorendar**, BSc
- **JT Mayhall**, BA, DDS, AM, PhD

Correspondence to: Karishma Kazim, Faculty of Dentistry, University of Toronto, 124 Edward St., Toronto, Ontario M5G 1G6. email: karishma_kazim@yahoo.ca

Abstract

This evidence-based report summarizes the strongest sources of evidence regarding the management of precarious coronal lesions. The review was based on evidence from two main sources: a search of several electronic bibliographic databases and a review of the references from relevant studies for additional potentially relevant articles. A total of 177 articles were reviewed. Of these, 14 were deemed relevant and were critically appraised utilizing the level of evidence classification system developed by the Canadian Task Force on the Periodic Health Examination and the "Evidence of Efficacy of Therapy Checklist". The evidence from 4 studies with a score of 10 or above was included in this review. Topical fluoride (in the form of varnish), sealants and chewing gum are recommended for managing precarious coronal lesions. The strongest evidence supports the use of fluoride varnish as an effective primary therapy. Sealant therapy can be recommended for pit and fissure precarious lesions. Chewing gum therapy can also be recommended, but as an adjunct.

***MeSH Key Words**: precarious, white spot lesion, fluoride, sealants, management*

A precarious lesion is a lesion occurring before, or early in, the development of caries[1]. Terms such as white-spot, early enamel caries, incipient lesion, demineralization, and non-cavitated lesion are synonyms for precarious lesions. Initially, acidic challenge of enamel results in subsurface demineralization where the surface of the enamel remains intact. Such a lesion represents an early stage in caries progression when remineralization is possible. If conditions favouring demineralization continue to predominate, the lesion will progress to a point where the intact enamel surface cavitates due to continued dissolution of subsurface mineral. At this point, remineralization of the lesion is unlikely.

The proverb “drill and fill” is used by some to describe dentistry when restorations are considered the primary treatment option. While this method is effective in eliminating the carious lesion, it also results in the permanent loss and structural weakening of tooth structure. Such an invasive procedure includes the possibility of recurrent caries or restoration failure, leading to further removal of tooth structure. Today, we understand that dental caries is a progressive process that, in its early stages, can be reversed through remineralization. As dental practitioners, our goal should be to attain caries reversal wherever possible before resorting to the drill.

This report is aimed at the management of precarious coronal lesions among the general population who have access to dental care.

Topical fluoride application, sealants, chewing gum, ozone, laser, air abrasion, and antibacterial rinses have been cited as methods for managing precarious coronal lesions. To date, there is insufficient evidence identifying the optimum method for

management. This evidence-based report summarizes the strongest sources of evidence regarding management of precarious coronal lesions.

Methods

Two types of searches were carried out to identify potentially relevant articles. Initially, the keywords precarious coronal lesion, white spot lesion, demineralization, incipient lesion, non-cavitated lesion, and early enamel caries, were all used to define the problem. These keywords were used in combination with various methods of treatment, such as fluoride, chewing gum, sealant, air abrasion, laser, ozone and antibacterial rinses.

The electronic search engines PubMed (1966 – present) and MEDLINE (1966 – present) were used to conduct the search limited to human subjects and published in English. At the title stage of the search, articles relevant to the topic yielded 67, 6, 31, 7, 32, 11, and 6, for fluoride, chewing gum, sealant, air abrasion, laser, ozone and antibacterial rinses, respectively. The abstracts of these articles were reviewed and the literature cited in these articles were used to identify an additional 17 potentially relevant articles. Of the 177 articles collected, all abstracts were reviewed and rejected based on inclusion/exclusion criteria, yielding 14 potentially relevant articles. The strength and the quality of these studies were evaluated according to the level of evidence classification system developed by the Canadian Task Force on the Periodic Health Examination and the checklist (Table 1). From this, 4 studies with a score of 10 or above were included in the evidence table (Table 2).

An article was rejected at the abstract stage if it did not meet all of the following criteria: 1) It reported primary research or was a review. Any meta-analysis, commentary or non-published articles were excluded. 2) The study design for primary research was one of randomized controlled trial, cohort study or case-control study. 3) Only in-vivo, *in situ* or clinical study designs were included.

Findings

Strong evidence supports the following options for managing precarious coronal lesions (Table 2).

Topical Fluoride Therapy

There is considerable variation in the potential of topical fluoride varnish to reduce the incidence of caries. A nine-month study[2] assessed the effect of fluoride varnish (Duraphat®) on early enamel occlusal carious lesions in primary teeth. Children between the ages of 3 and 5 years were selected and randomized into the varnish and control groups. The experimental group received varnish at baseline and four months. The control group did not receive any professional fluoride application for the duration of the study. Results indicated significantly more inactivated lesions in the varnish group at nine months. Another study[3] examined the effect of fluoride varnish (Duraphat®) on proximal caries progression in teenagers over a three-year period. A sample of 14 year olds was randomly allocated into a varnish and control group. Both groups received a

fluoride rinse (0.2% NaF solution) every two weeks. The test group also received varnish application every three months for the duration of the study. The results showed a significant reduction in the progression of proximal carious lesions for the varnish group. Overall, the results suggest that fluoride varnish application can potentially reverse active enamel lesions in both the primary and mixed dentition.

Sealant Therapy

The use of pit and fissure sealants has largely focused on the prevention of occlusal caries. More recently, sealants have been implicated in the treatment of incipient occlusal enamel lesions. The number of studies investigating the preventive role far outnumbered those examining the treatment role. A twelve-month study by Florio *et al.* [4] evaluated non-invasive treatment applied to occlusal surfaces. Children at the age of 6 were randomized into two test groups and one control group. One test group received fluoride-leaching resin modified glass ionomer (Vitremer®) sealants. The other test group received a professional fluoride varnish (2.26% NaF Duraphat®) every six months. All groups, including the control, were instructed to rinse with 0.2% NaF weekly and given oral hygiene instructions. Results indicated that sealants completely arrested such enamel lesions compared to the professional fluoride varnish and control.
Overall, this study suggests that pit and fissure sealants are a potentially non-invasive treatment option for incipient occlusal lesions.

Chewing Gum Therapy

During the past 30 years, several studies have shown that a daily intake of chewing gum, specifically xylitol gum, resulted in a reduction of caries[5]. A forty-month study conducted by Mäkinen *et al.* [6] investigated the effect of chewing gum usage on caries rates. In a double-blind prospective cohort study, 1,277 high caries risk children (mean age 10.2 years) were assigned to eight supervised gum-chewing groups and one control group (four xylitol gum groups, two xylitol/sorbitol gum groups, one sorbitol gum group, one sucrose gum group, and one no gum use group). The test subjects were given either sticks or pellets to chew 3 or 5 times/day for 5 minutes/session. Results suggest that polyol-based chewing gums, such as those containing xylitol and sorbitol, significantly reduce caries rates. The largest reduction in caries rates was observed in those subjects who were instructed to chew xylitol-only pellets 5 times/day (RR = 0.27; 95% CI 0.20-0.36). Chewing gum containing only sucrose demonstrated a slight increase in the onset of caries. Similar results were found in a twenty four-month prospective cohort study by Kandelman and Gagnon in which the effect of chewing xylitol gum on the incidence and progression of dental caries was tested in a sample of 274 children, aged eight and nine years, of low socio-economic status and high caries rate[7]. The children were divided into two test groups (15% and 65% xylitol gum distributed 3 times/day) and one no gum (control) group. Results for the two gum chewing groups were similar and demonstrated that chewing xylitol gum had a beneficial effect on the caries process for all types of tooth surfaces, and especially for bucco-lingual surfaces[7].

Discussion

Based on this systematic review, the evidence suggests topical fluoride, sealants and chewing gum as effective management methods for precarious coronal lesions. Alternative techniques include air abrasion, ozone, laser therapy and antimicrobial rinses. However, lack of strong evidence prevents the recommendation of these methods for clinical practice.

Fluoride Therapy

The literature cites various methods of professional topical fluoride application. Practitioners mainly use varnish, gel or rinse. Of the three formulations, studies[2, 8, 9] suggest that fluoride varnish is more effective than gel due to its increased fluoride content. This leads to an increased calcium fluoride coating on the enamel surface that may last for weeks to months, enhancing exposure time of fluoride to tooth surfaces. The gradual release of fluoride into plaque, saliva and enamel aid in reducing enamel solubility to acid, and have a bacteriostatic and bacteriocidal effect. Thus, fluoride ions participate in inhibiting demineralization and promoting enamel remineralization[10, 11]. From the dentist's perspective, varnish is easier to apply, is less technique sensitive, and reduces chair time. Although, varnish temporarily discolours the teeth on the day of application, patients still prefer varnish to gel because of less discomfort during application and less toxicity, especially in children.

Sealant Therapy

Although the evidence is not as strong as that pertaining to their caries-preventive effects, pit and fissure sealants have more recently been advocated for the treatment of occlusal incipient lesions. When properly placed, pit and fissure sealants are able to impede early enamel demineralization from progressing to a carious and/or cavitated lesion[4]. A five-year retrospective study by Heller *et al.* [12] further supports this claim. Sealants placed over demineralized occlusal surfaces deprive the bacteria from essential nutrients, thus inhibiting further demineralization of tooth material[13]. Fluoridated-sealant materials also aid in the inhibition of bacterial activity and the remineralization of tooth structure[4]. A sealant's ability to halt the demineralization process relies on the presence of an intact seal. It has been estimated that fissure sealants have a failure rate of approximately 5 to 10% per year, necessitating a requirement for biannual maintenance and repair as needed[14]. Inadequate maintenance and repair of fissure sealants are contraindicated for the treatment of precarious occlusal lesions. Then, other options need to be considered.

Chewing Gum Therapy

Due to its ease of use, low cost and accessibility, chewing gum can serve as an adjunct method in reducing the onset of caries. Mäkinen *et al.* [6] suggest a dose-response relationship between xylitol concentrations and the onset of caries. The groups who were instructed to chew gum 5 times/day versus 3 times/day experienced a greater reduction in

caries rates. Thus, there seems to be an association between the frequency of gum chewing and the onset of caries. Xylitol is not metabolized to acids in pure cultures of oral microorganisms *in vitro* or in dental plaque *in vivo*[5]. Chronic consumption of xylitol-sweetened chewing gum has shown to suppress *Streptococci mutans* and reduce the amount and adhesiveness of dental plaque[5]. In addition, both the gustatory and masticatory properties of chewing gum stimulate salivary flow, resulting in an increase in salivary pH. This leads to a net influx of salivary minerals into the teeth, thereby promoting remineralization.

Air Abrasion Therapy

Air abrasion has been suggested as an alternative method for halting the progression of coronal lesions. However, air abrasion necessitates the cavitation of enamel. So, it is not recommended as a viable method for the treatment of non-cavitated coronal lesions.

Ozone Therapy

It has been suggested as an alternative technique that might reduce the number of cariogenic bacteria, possibly arresting the progression of a carious lesion. However, the evidence found to support this claim was conducted by Kavo, the manufacturer of the product HealOzone®. Given the high risk of bias in these studies, no reliable evidence was found[15].

Laser Therapy

An *in vitro* study[16] showed the use of argon laser at low energy density on enamel resulted in a three-fold increase in fluoride retention. However, no *in vivo* studies suggest a correlation with faster enamel remineralization or increased resistance to demineralization, and higher fluoride retention.

Antibacterial Rinse

Studies[17, 18] show that chlorhexidine is effective in reducing oral bacterial counts. A study by Katz[19] showed possible remineralization of incipient lesions. A combination of chlorhexidine and 0.05% NaF rinse was administered to irradiated patient with low salivary flow. However, no randomized clinical trials have shown that chlorhexidine is directly responsible for reducing incipient caries.

Future research investigating management methods for precarious coronal lesions should consider the following recommendations.

- A randomized controlled trial comparing the effectiveness of fluoride varnish, fluoride gel and fluoride rinse solution
- A randomized controlled trial with a large sample size comparing the effectiveness of sealants to a control group
- A randomized controlled trial examining the effectiveness of a non-fluoride releasing sealant

- A clinical study investigating the effectiveness of xylitol, sorbitol and sucrose containing gums compared to a control group receiving no chewing gum
- A clinical trial on ozone therapy conducted by a third party to eliminate any bias in the reported findings
- An *in vivo* study examining any relationship between fluoride retention and remineralization or demineralization on lased enamel
- A randomized controlled trial examining any relationship between chlorhexidine and reversal of incipient caries

Conclusions

Upon review of the clinical trials topical fluoride, sealants and chewing gum can be recommended for managing precarious coronal lesions. The strongest evidence supports the use of fluoride varnish as an effective primary therapy. Sealant therapy can be recommended for pit and fissure precarious lesions. However, sealants must be monitored, maintained and repaired as necessary. Chewing gum can also be recommended, but as an adjunct. The cost of fluoride varnish application is cheaper than sealants but comparable to chewing gum. Fluoride varnish should be professionally applied every three months to treat active white spot lesions. The current standard of care is to apply topical fluoride every six months to prevent caries.

Acknowledgements

We would like to express our thanks to Dr. JT Mayhall for providing guidance, support and advice.

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Table 2: Management Methods for Precarious Coronal Lesions

Author, Date, Study Design	Population	Intervention/Test Treatment	Control Treatment	Outcome	Critical Appraisal	Conclusion & CTF Rating
Modeer *et al.*, 1984[3], RCT	Randomly selected 14 y/o m/f children with enamel proximal caries in the Municipality of Huddinge, Stockholm, Sweden (N = 194).	0.2% NaF rinse every 14 days and 5% NaF varnish (Duraphat®) every 3 months for 3 years (N = 87)	0.2% NaF rinse every 14 days for 3 years (N = 107).	Test group: Outer ½ enamel 7% regressed 33% no change 25% progressed Inner 1/2 enamel 2% regressed 36% no change 62% progressed Control Group: Outer ½ enamel 7% regressed 32% no change 31% progressed Inner ½ enamel 0% regressed	**Checklist Score:** 13/16 = 81% · validity challenged because of radiographic occurrence of false positives and false negatives · treatment effect might not be large enough to be clinically important due to the small sample	Significant difference in the reduction of caries progression between subjects treated and not treated with topical fluoride varnish. **CTF Rating:** Level I-A

				21% no change 77% progressed Mean % reduction of enamel proximal caries	size	
Autio-Gold and Courts, 2001[2], RCT	Randomly selected 3-5 y/o m/f children attending nursery school in Alachua County, Florida (N = 142).	5% NaF varnish (Duraphat®) at baseline and at 4 months (N = 59)	No varnish (N = 83)	d_es Test Group: Baseline 7.00 ± 5.72 9 months 1.20 ± 1.96 Control Group: Baseline 5.21 ± 3.96 9 months 3.05 ± 2.99 % of lesions that regressed from active to inactive	**Checklist Score:** 13/16 = 81% · loss to follow up 27% · treatment effect might not be large enough to be clinically important due to the small sample size · no specification of whether care	Significant difference in the number of inactivated enamel lesions between subjects treated and not treated with topical fluoride varnish. **CTF Rating:** Level I-A

				Test Group = 81.2% Control Group 37.8%	was received outside of the study and controlled for	
Flório *et al.*, 2001[4], RCT	Randomly selected 6 y/o m/f children attending public day nursery school in São Paulo, Brazil in 2000 (N = 34).	Group 1: RMGI (Vitremer®) sealant (N = 12; n_t = 35) Group 2: 2.2% Fluoride varnish (Duraphat®) every 6 months (N = 11; n_t = 36)	Group 3: OHI and patient-applied 0.2% topical NaF (N = 11, n_t = 37)	% of arrested precarious lesions: Group 1 = 100% Grouip 2 = 83.3% Group 3 = 72.7% $P < 0.05$	**Checklist Score:** 12/16 = 75% · no specification of whether care was received outside of the study and controlled for · duration of study might be insufficient due to possible sealant failure beyond twelve months	Significant difference in the number of arrested precarious lesions between sealed and non-sealed tooth surfaces. **CTF Rating:** Level I-A

					· examiners were not blinded · treatment effect might not be large enough to be clinically important due to the small sample size · lack of independent comparison between test and control groups	
Mäkinen *et al.*, 1995[5], Double-blind Prospective Cohort	Non-randomly selected m/f children (mean age 10.2 years) with high caries	Group 2: Sugar-s5 (N = 119) Group 3: Sorb-p5 (N = 129) Group 4: 3:2 XS-	Group 1: No gum (N = 121)	Risk of caries onset on sound tooth structure: Group 2: RR = 1.20	**Checklist Score:** 11/16 = 69% · loss to follow-up 33% · strongest study	Significant difference in the risk of caries onset between chewing gum use (especially xylitol-containing

	risk attending public school in Belize City, Belize in 1989 (N = 1,135).	p5 (N = 120) Group 5: 1:3 XS-p5 (N = 121) Group 6: Xyl-s3 (N = 141) Group 7: Xyl-s5 (N = 126) Group 8: Xyl-p3 (N = 133) Group 9: Xyl-p5 (N = 125)		(95% CI 0.96-1.49) Group 3: RR = 0.74 (95% CI 0.60-0.92) Group 4: RR = 0.56 (95% CI 0.44-0.71) Group 5: RR = 0.49 (95% CI 0.38-0.65) Group 6: RR = 0.48 (95% CI 0.37-0.61) Group 7: RR = 0.44 (95% CI 0.34-0.56) Group 8: RR = 0.41 (95% CI 0.31-0.54) Group 9: RR = 0.27 (95% CI 0.20-0.36)	design not used to assess efficacy · not randomized groups dissimilar at baseline → confounding variables: i) socio-economic status ii) oral hygiene practices iii) professional dental care outside study	gums) and no gum use. **CTF Rating:** Level II-2 - B

LEGEND

CTF = Canadian Task Force

RCT = Randomized Controlled Trial

y/o = year old

m/f = male and female

des = decay at enamel surface

RMGI = resin-modified glass ionomer

N = number of human subjects

$\mathbf{n_t}$ = number of teeth

Sugar-s5 = ~60% sucrose/8% corn sweetner stick gum 5 times per day (“sucrose gum”) for 5 minutes per session

Sorb-p5 = ~65% sorbitol pellet gum 5 times per day (“sorbitol gum”) for 5 minutes per session

3:2 XS-p5 = ~45% xylitol/30% sorbitol pellet gum 5 times per day for 5 minutes per session

1:3 XS-p5 = ~15% xylitol/45% sorbitol pellet gum 5 times per day for 5 minutes per session

Xyl-s3 = ~60% xylitol/9% Lycasin® stick gum 3 times per day for 5 minutes per session

Xyl-s5 = ~60% xylitol/9% Lycasin® stick gum 5 times per day for 5 minutes per session

Xyl-p3 = ~65% xylitol pellet gum 3 times per day for 5 minutes per session

Xyl-p5 = ~65% xylitol pellet gum 5 times per day for 5 minutes per session

Table 1[20]**. Checklist to assess evidence of efficacy of therapy or prevention**
1. Was the study ethical?
2. Was a strong design used to assess efficacy?
3. Were outcomes (benefits and harms) validly and reliably measured?
4. Were interventions validly and reliably measured?
5. What were the results? i) Was the treatment effect large enough to be clinically important? ii) Was the estimate of the treatment effect beyond chance and relatively precise? iii) If the findings were "no difference" was the power of the study 80% or better?
6. Are the results of the study valid? i) Was the assignment of patients to treatments randomized? ii) Were all patients who entered the trial properly accounted for and attributed at its conclusion? a) Was loss to follow-up less than 20% and balance between test and controls? b) Were patients analyzed in the groups to which they were randomized? iii) Was the study of sufficient duration? iv) Were patients, health workers, and study personnel "blind" to treatment? v) Were the groups similar at the start of the trial? vi) Aside from the experimental intervention, were the groups treated equally? vii) Was care received outside the study identified and controlled for?
7. Will the results help in caring for your patients?

i) Were all clinically important outcomes considered?

ii) Are the likely benefits of treatment worth the potential harms and costs?