

Do we have effective preventive clinical (professionally applied or prescribed) interventions for root caries?

-An evidence-based study-

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Abstract:

Root caries is a clinical challenge for the dental professional. As restoration of root caries is often difficult; every effort should be made to prevent their occurrence. The elderly dentate population who are most at risk of developing root caries is increasing, resulting in a greater need for the prevention and treatment of root caries. This evidence-based study examines four approaches to prevention and treatment of root caries: 1. fluoride (tablets, fluoridated water, dentifrices), 2. dental varnishes, 3. diet , oral hygiene and salivary stimulants and 4. ozone in an attempt to determine the best available clinically applicable preventive and treatment strategy .

A thorough search of electronic databases yielded 105 potential studies, 28 were retrieved and 11 were deemed relevant for inclusion in this study. Each study was evaluated using an “efficacy checklist” involving 17 items¹. Studies on fluoride for prevention and treatment of primary root caries lesions (PRCLs) achieved the best scores and were also assigned the highest design strength and level of evidence. Studies on fluoride varnishes and ozone on both sound exposed roots and on existing PRCLs were both promising but require further investigation. Studies on salivary stimulants were of poor quality and showed statistically insignificant results for the prevention and treatment of PRCLs. There is strong evidence that water fluoridation(1.0-2.0ppm) is the most effective, equitable and efficient preventive measure for root caries lesions. Only systemic and topical fluorides had sufficient evidence to be recommended as efficient prevention for PRCLs. Clinical evidence and review results suggest a team centered approach with a strong accent for improved research to advance patient care in the population at risk for root caries.

DEFINITION, DIAGNOSIS AND EPIDIMIOLOGY:

Root caries is a disease that affects an area on the surface of the tooth, at or apical to the cemento-enamel junction (CEJ) that has undergone clinically or radiographically apparent demineralization of the exposed surfaces^{1, 2}. This process involves the cementum first, although in some cases it begins in dentine. There is both loss of mineral and protein (proteolysis) in root caries.

Remineralization involving the dentine has been shown to take place on the remaining mineral content rather than on the protein infrastructure³. Root caries most often occurs supragingivally, at or close to (within 2 mm) the cemento-enamel junction^{3,4}. Lesions may spread sublingually or be found subgingivally in the event that cariously affected tooth surface leads to greater plaque retention with resultant gingival edema⁵.

The primary initiating agent of root caries is generally accepted to be *Streptococcus mutans*, although animal models and clinical data suggest strongly adjunctive roles for *Lactobacillus* and *Actinobacillus*. Yeasts such as *Candida albicans* have frequently be identified in soft lesions but are not to be thought to be responsible for initiating them².

Clinically, root caries appears as white (in the earliest stages) or discolored (tan, brown or black) areas of irregular outline, with or without cavitation, on an exposed root area. A sharp explorer can be introduced into root caries under mild to moderate pressure². Beighton and others have demonstrated that tactile characteristic of a lesion (soft versus leathery versus hard are more superior to color for sound from carious root structure^{2,3} .

Root caries lesions occur predominantly on the exposed buccal surfaces and least prevalent on the lingual. Mandibular molars when present and exhibiting gingival recession are

the most susceptible to rot decay. Prevalence among susceptible surfaces in mandible is highest in posterior and decreases in anterior. This trend is opposite in the maxilla^{2,4} .

ETIOLOGY, INCIDENCE AND PREVALENCE:

Root caries is a multifactor disease. Incidence of root decay significantly increased with xerostomia (resulted from different diseases and medications), poor oral hygiene, diet high in refined carbohydrates, poor general health, low socioeconomic standing and less dental care¹⁰ . Positive correlation between the number of carious coronal surface lesions and carious root surface lesion has been found in different studies.^{6,7}

According to a cross-sectional study by D. Locker and J. L. Leake in a population of 907 subjects aged 50 and over in Ontario, 70.9 percent of population had at least one root DFS. The percent D/DFS was 20.0. The numbers of Root DS was positively associated with the number of decayed crown surfaces and mean periodontal attachment loss and negatively associated with the number of remaining teeth. Males had more root DS than females.⁷

A longitudinal study of 3 years incidence of root caries in an older Canadian population (1989-1992) showed 27.4 percent of population developed one or more root DFS increments, and mean DFS was 0.6 per person⁸ . The incidence was almost twice as high in those aged 75 years and over. Predictors of root caries incidence was wearing partial denture, current and previous smoking habit, visiting dentist on irregular basis, fair or poor general health, brushing less than twice a day, and mean loss of periodontal attachment of more than 4 mm⁸ .

In a systematic review by J.L. Leake four patients aged thirty and older, the prevalence of root caries is roughly 20 to 22 percent less than a person's age. Severity reaches over one lesion by age fifty, two lesions by age seventy, and just over three lesions for those seventy-five and older. About 8 percent (odds of 1:11) of the population would be expected to acquire one or more new root caries lesions in one year. ¹⁰

METHODS

Search Strategy

Three electronic databases were used in the original search: Pub Med, Ovid and Cochrane (1985 to present). Search engines such as Google and Yahoo were also considered for relevant information. The searches were limited to in-vivo studies printed in English language. Using "root caries" as the initial search term, a group of studies were identified from all the databases. These studies were evaluated for relevance to the study based on the title alone. Second search was carried out using term "root caries, prevention and intervention" Abstracts of those deemed to be appropriate for inclusion were examined and all papers with potential relevance were retrieved. Textbook references were also searched using UofT library catalogue. Textbooks, which include information regarding etiology, prevalence, diagnosis and effective preventive measures for root caries, were used. Experts in this field from the faculty of dentistry were consulted for valuable guidance. Finally reference lists from relevant articles were reviewed for more possible sources.

Study selection

In the abstract stage, queries limited to in-vivo studies in English language yielded 105 potential studies. Following the elimination of duplicate articles, a total of 72 remained.

Out of these 72 articles, 28 were retrieved. Remaining studies were eliminated on the basis of title (either irrelevant to the topic or incorrect population sample). Articles with inconclusive or contradictory evidence were disregarded. Out of 28, 12 were included in this study. Articles were considered relevant if they met the following criteria: a) the primary search b) a score of more or equal to 10/17 on the checklist to assess the efficacy of therapy or intervention (figure 1), c) strong and moderate design (evidence table), d) strength of evidence as per guideline set by Canadian Task Force For Preventive Health Care. Exceptions were accepted for studies in diet and oral hygiene because of insufficient level of evidence and research database.

Validity Instrument

Twice two reviewers scored all articles examined at full text level independently using the checklist to assess the efficacy of therapy or intervention (figure 1). The maximum possible score was 17. Studies used for background information for this report were also appraised with appropriate checklist.

Data extraction

Data extraction sheet was adapted from evidence-based practice producing an evidence-based report by JL Leake, May 2006 (appendix 2). Two independent then extracted general information about each relevant study including authors, population description, intervention, control, outcome, critical appraisal comments/score and conclusion.

1. Topical fluoride

Lifelong exposure to water containing optimum levels (1ppm or pro rata for the climatic conditions) of fluoride reduces the prevalence of root caries and the effect is 'dose related'.

The variation in critical pH for dentin when compared to the enamel and the relatively greater uptake of fluoride by dentin, when compared to enamel must affect the dose-response gradient for fluoride and the method of fluoride delivery (neutral/acidulated, solutions/gel/foam). New toothpastes with high fluoride concentrations of fluoride (up to 5000ppm) are now available to facilitate this process.¹²

The six included studies demonstrated the efficacy of topical fluoride in prevention of root caries.

One study shows that salivary fluoride exposure to root caries risk areas was strongly increased when fluoride tablets were placed in the vestibule in these areas. The unflavored tablet had higher fluoride retention in saliva than did flavored brand. The rapid loss of fluoride from plaque in slow clearance risk areas indicates that more than one daily treatment would be required for elderly caries risk subjects.¹¹

Three studies established clinically significant benefits of dentifrice containing 5000 ppm compared with 1000 ppm. One study looked at radiation therapy population and concluded that remineralizing toothpaste is significantly superior to the conventional fluoride toothpaste in preventing root caries in high risk patients ¹³

Other two studies demonstrated that 5000ppm fluoride toothpaste remineralized root caries lesions, supporting dose effect-relationship in root caries prevention ^{14, 15.}

Two studies showed the differences in root caries levels in two similar communities with contrasting natural water fluoride levels. One of the studies included population of Stratford, Ontario (1.6 ppm) and Woodstock, Ontario (.2 ppm). 500 subjects were chosen from each community and it was concluded that lifelong adult resident in a naturally fluoridated community (1.6 ppm fluoride) have substantially fewer root caries lesions than their counterpart residents in a nearby similar but nonfluoridated community (.2ppm). The descriptive data also suggest that caries experience on exposed root surfaces is both age and gender related . ^{16, 17.}

2. Dental Varnishes:

Three randomized control trial reviewed regarding the effects of chlorhexidine and fluoride varnishes. Good evidences in all of these studies supports effectiveness of CHX varnishes when combined with fluoride. ^{18, 19,20}

In one study a total population of 108 elderly with root caries in 2 control and test groups examined. The test group received fluoride varnish applications to the lesions, after drying the fluoride varnish was overlaid with antimicrobial varnish, that contained 1%

Chlorhexidine and 1% Thymol . The placebo group received a fluoride varnish (Fluor-Protector) and the placebo varnish was overlaid on the fluoride containing varnish in the same manner as described for test group. The applications of varnish repeated at 6, 13, 26 and 39-week intervals .The clinical severity of the lesions in the test group did not change significantly during the 12 month period. In the placebo group the mean lesion width, lesion height and the length of exposed root increased substantially and the lesions were significantly closer to the gingival margin.¹⁸

Second study done by S.Ekenback and all evaluated the effect of four dental varnishes on the colonization of cariogenic microorganisms on exposed sound root surfaces . 65 individuals studied in Sweden had applications of Cervitec(1% CHX + 1% thymol), custom made 1% thymol varnish 2 other fluoride varnishes 1% and 5% . They found that Cervitec varnish had statistically SIGNIFICANT effect over time on the number of mutans streptococci.

Although the application of fluoride varnishes didn't show any significant reduction in the colonization of S. mutans, it may have effects on the micro flora of the dental plaque.¹⁹

Combination of Fluor- Protector and Cervitec is a useful, simple, quick and non-invasive method for the control and management of the existing root caries. ¹⁸

3. Combination of dental sealants and Ozone:

We reviewed one RCT , and one systematic review.

In the study by Brazilli and all, a systematic review of the effectiveness of Heal Ozone for management of dental caries carried out. Two studies assessed the use of Heal Ozone for management of primary non-cavitated root caries, which reported high success rates for ozone

treated lesions and no significant changes in the control lesions (despite application of topical fluoride). The evidence base for HealOzone is insufficient to conclude that it is a cost-effective addition to the management and treatment of root caries.²¹

In another randomized control trial study 69% of leathery non cavitated primary root caries was arrested non-operatively with ozone combined with remineralizing products.²³ According to a published textbook, Root sealant (Seal& Protect, Dentsply, Germany) in conjunction with ozone application performs better when compared to those in the sealant group only, this observation may be related to the oxidative and permeability effects of ozone allowing remineralization of primary root caries lesions. The root sealants can be retained better on ozone treated leathery PRCLs²²

4. Diet and Oral hygiene instruction:

There are few studies done regarding relationship of diet and root caries, but strong evidence has been mentioned in published textbooks about association of frequency of sugars intake and prevalence of caries. Data from the UK National Diet and Nutrition Survey demonstrated that the risk of root caries being present was approximately doubled where the frequency of sugars intake exceeded nine episodes per day. The dietary problem is particularly acute in the institutional settings^{6,12}

Study done by Papas et Al (in 1995 American Clinical Nutrition 1995) reported on the relationship between the root caries and diet. The contributing factors thought to increase the rate of root caries, were sugar intake, malnutrition and poor oral hygiene. Also the study has shown that subjects on diet high in complex carbohydrate exhibits a low prevalence of coronal

caries but a high prevalence of root caries. Those who were caries-free consumed more foods containing crude fiber, calcium, magnesium, phosphorus and protein whereas those who had developed root caries consumed significantly more refined sugar, sucrose, glucose and fructose. Also those who did not develop root caries ate twice as much cheese as did those who had a high incidence of root caries. Root caries prevailed in subjects, which had a high intake of liquid sugar and sticky sugars and 25% more solid sugars such as cakes and cookies. Regarding the frequency of meal patterns, the data from 2 3-days diaries revealed that subjects who were in the highest quartile of frequency of sugar consumption had significantly more caries than did those in the lowest quartile. In conclusion the authors conclude that both amount and frequency of sugar consumption are important factors in the development of root caries²⁴

There are controversial findings about effect of tooth brushing in reducing of root caries, we couldn't find strong evidences regarding this issue.

On the other hand, a study done by Nyvad and all on 24 active tooth surface lesions strongly supports effect of brushing with a fluoride tooth paste (F=0.1%). In this study, which was done within a period of 2-4 months, all lesions had changed from soft, greasy, and yellowish to leathery or hard, indicating a gradual transition from active to inactive stages of caries.²⁵

5. Polyol combinant saliva stimulants:

According to a Makinen E. Al study on Veteran affairs patients daily use of Xylitol containing chewing gums or saliva stimulating lozenges with Xylitol reduced new root lesions

by 80% over an average 21 months period in a group of 40 veterans. The oral health status appeared to be favorably affected by the usage of saliva stimulants²⁶.

DISCUSSION

Upon reviewing of literature a few approaches of clinical intervention could be adopted for the prevention of root surface caries in the elderly dentate population. Recession of the gingival margin is an inevitable result of poor oral hygiene & gradual loss of periodontal attachment with age. In younger age groups root exposure occurs as a result of improper plaque control procedures.

The incidence of root decay significantly increases with the gingival recession, xerostomia, poor oral hygiene, carbohydrate rich diet, poor physical health, low socioeconomic status and lack of appropriate dental care.¹⁰

Studies presented the strongest evidence of topical fluoride effectiveness as a clinical preventive intervention. All six studies support the dose related beneficial effects of Fluoride in prevention & treatment of RC. High concentration (5000ppm) Fluoride dentifrices were demonstrated to remineralize root caries further supporting the dose effect relationship in RC prevention. Fluoride could be delivered neutral/acidulated forms or as gel/foam/solution forms. Residents of areas with natural water fluoride levels (1.6ppm) had substantially fewer RC lesions than their counterparts in a nearby similar but non fluoridated community (0.2ppm)^{16, 17}

Effectiveness of dental varnishes was evaluated in 3 Randomized controlled trials using Flour Protector with and without 1% Chlorhexidine + 1% Thymol. In one study the clinical severity of the lesion in the test group did not change significantly in the 12-month study period

while the placebo group RC lesions width & height increased substantially. The other study by Ekenback evaluated dental varnish effect on the colonization of cariogenic microorganisms on exposed sound root surfaces. CHX+Thymol showed statistically significant effect on the number of S.Mutans while F varnishes showed no significant reduction in colonization of S.Mutans but may have some effect on the microflora of dental plaque. Combination of Fluor-Protector and Cervitec is a useful simple, quick and non-invasive method.^{18,19,20}

Another tool in prevention of root caries is Ozone along with root sealants. One RCT & one systematic review were considered for the effectiveness of Dental Sealants & Ozone, The application of root sealants in conjunction with ozone performs better when compared to sealants only.²² However the evidence was insufficient to conclude that it is an effective addition to a clinical preventive program for prevention of RC.

Data from the UK Natl Diet & Nutrition survey demonstrated that the risk of root caries was approximately doubled where the frequency of sugar intake exceeded 9 episodes per day. This is particularly true in an institutionalized setting.

A study by Papas reported the relationship between RC & diet. They concluded that both amount and frequency of sugar consumption are important factors in development of root caries. The type of carbohydrate, fiber containing food, sugar (liquid and sticky) and frequency of the food intake affected the caries experience. The food with high fiber, calcium, magnesium, phosphorous and protein didn't cause any decay whereas those who consumed more refined sugars had root caries.²⁴ Nyvad demonstrated a gradual change from soft greasy & yellowish to leathery or hard with effective brushing with a fluoride paste.

Salivary stimulants (xylitol chewing gum or lozenges) reduced new root lesions by 80% over 21 months in a group of veterans.

CONCLUSION

The use of Topical Fluoride in the prevention and treatment of root caries has some support in the literature we reviewed. However more research regarding dosage, frequency and method of application using appropriate study designs is strongly recommended given the predicted increase in RSC in our aging population. The studies we reviewed were limited in design, not accounting for confounders like diagnostic variation, previous F exposure, OH skill levels etc.

Efficacy of dental varnishes in prevention of RC is not conclusive from the articles we reviewed. A lot more research into dietary patterns and age related changes (diet and motor skill) is needed to enable dental professionals to adequately treat and prevent RC thereby reducing the currently predicted inevitable burden that will be placed on society.

Table 1

Review of Evidence	Number
Abstracts matching search terms	105
Articles identified through alternate means	3
Articles rejected at title stage	70
Articles rejected at abstract stage	10
Articles retrieved and copied for review	28
Articles rejected at first reading	11
Articles scored	17
Articles meeting cutoffs	11

Table 2

Authors (Year of publicatio n)	Study Setting: Age / population Method	Control	Test	Findings	Strength of evidence/ Classification/ Critical appraisal
Arneberg, Hossain , Jokstad 2005	6 subjects Age 60-70 Prospective, Experimental to improve fluoride tab. program	Placemen t of fluoride tabs sublingua l	Placement of F. tabs in vestibule of root caries risk areas	Plaque fluoride levels Measured at intervals Fluoride exposure strongly increased by placing tablets in vestibule 3.6 ppm (sublingual) 10.2ppm (vestibule)	II-3,B Ranking: 12/17 Moderate design
Papas, Russel, Singh 1999	50 subjects, cancer pt received>>50Gy More than 18 yrs. Old Double blind RCT , 1 yr duration To compare remineralizing tooth paste w regular paste	Used regular fluoride tooth paste (1150 ppm)	Exposed to Enamelon Toothpaste (F+Ca/Phosph ate salts)	Remineralizing dentifrice significantly superior Net root caries inc./mo.: Conv. :0. 45 Remin:0. 06	I, A Ranking: 13/17 Good design
Baysan Lynch Ellwood 2001	201 subj, 114 male, 87 female 27-90 yrs 6 mo. Duration Double blind RCT Compare to fluoride dentifrices	Used 1100 ppmF	Used 5000 ppm Prevident 5000	5000 ppm. Toothpaste better at remineralization 55% noncavitated root lesions reversed vs 15%	I-A Ranking: 14/17 Strong design
Hunt Eldrege Beck 1989	451 residents Ave 74.1 18 mo. Duration incidence Repeated cross-sectional Compare caries incidence in fluoridated and non- fluoridated communities	Non- fluoridate d communi ty	Fluoridated for>>40 years	Root caries incidence significantly less among residents for>40 yrs in fluoridated community 0.56 vs 1.11 surfaces	II-3 A Ranking:11/ 17 Moderate design
Stamm , Banting Imrey 1990	504 residents of fluoridated 465 residents of nonfluoridated 17-60 Cross sectional	0.2 fluoridate d Natural water	1.6 ppm fluoride in water	Root caries experience was 62% higher in nonfluoridated community	II-3 A Ranking: 11/17

	Exposed root caries prevalence				Moderate design
Brailsford Fiske 2002	108 subjects, elderly Randomized double blind longitudinal study Tx repeated 5x in 12 months Leathery root caries coated w/ Fluor-Protector +/- Cervitec	Soft root caries coated w/ Fluor-Protector	Root caries coated w/ Fluor-Protector and Cervitec	In test group the mean lesion width, height, length reduced significantly Lesions closer to gingival margin	I-A Ranking: 13/17 Strong design

Table 3

Authors (Year of publication)	Study Setting: Age / population Method	Control	Test	Findings	Strength of evidence/ Classification/ Critical appraisal
Ekenback Linder Lonnie 2000	65 individuals w/ >3 exposed sound root surfaces 37-81 yrs old Randomized Control 4 groups tx w/ wt varnish at baseline and 1 w. Plaque sample taken 4x	3 groups: 1% NaF 5% NaF 1% thymol	1% CHX + 1% thymol	Significant reduction of S. mutans level in 1 week and 1 month after appl. of varnish w/ CHX	I-B Ranking: 10/17 Moderate design
Schaeken Keltjens Hoeven 1991	44 periodontal surg. Patient 44.4 average 1 yr. duration Randomized control Pts. w/ mean RCI=14.5% returned to clinic every 3 month	Profess. Tooth cleaning every 3 months	1-Duraphat varnish at mo.intervals 2-CHX varnish At 3 mo. Interval All w/ tooth cleaning	Percentage of hardening: 3% control 11% Duraphat 15% CHX	I-B Ranking: 10/17 Moderate design

Papas Joshi Palmar 1995	141 (54%F, 46% M) subjects Broad range population Cross-sectional study 3 day diet analysis	No control group		Root caries significantly assoc. w/wt recession, plaque & dietary intake, Amount and frequency of sugar consumption are imp. Sucrose assoc $r =$ 0.17	II-3 B Ranking: 13/17 Fair design
Nyvad Fejerskov 1985	10 adult patient 20-66 yr 24 active root surfaces 18 mo.	No control group	Oral hygiene instruction 2x/d brushing w/ F dentifrices 2%NaF topical appl. 2x	Within 2-6 months all soft lesions changed to hard, dark inactive	II-3 C Ranking:10/17 Poor design
Makinen Pemberton 1996	180 patients veteran affair pt. 56.6 average age w/wt Exposed root caries 6-30 mo. RCT Used gums/dragees contained Xylitol or sorbitol	1-Sorbitol chewing gums 8.5 gr.daily 5x in 16hr 2-non- participant	Xylitol Gums/dragees 8.5 gr.daily 5x in 16hr	risk for a root-surface lesion in test group was 19% of sorbitol group Both saliva stimulating products have improvement effect	I-C Ranking:11/17 Moderate design
Holmes 2003	89 subjects (60-82 yrs) Each w/ 2 soft root caries Double blind RCT 18 mo. Each lesion txed w/ air or ozone Recall 3-6-12-18 months	One lesion of 2 txed w/air instead of ozone	Ozone by HealOzone system For 40 sec	After 18 mo. 87(100%) of ozone- treated PRCL's reversed, only 1 lesion from control group reversed	I-A Ranking: 11/17 Strong design

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