Clinical Decision-Making for Coronal Caries Management in the Permanent Dentition

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Abstract: Optimal conservative treatment decisions to prevent, arrest, and reverse tooth demineralization caused by caries require probability estimates on caries risk and treatment outcomes. This review is focused on the use of the best scientific evidence to recommend treatment strategies for management of coronal caries in permanent teeth as a function of caries risk. Evidence suggests that assigning therapeutic regimens to individuals according to their risk levels should yield a significantly greater probability of success and better cost effectiveness than applying identical treatments to all patients independent of risk. Depending on caries risk levels, treatment decisions based on risk can minimize unnecessary surgical intervention by incorporating the best evidence to prescribe treatment regimens for the use of fluoride-releasing agents, sealants, chlorhexidine, or combinations of these products.

To provide the most beneficial treatment tailored to a given level of current risk and probable future risk, dentists must be able to reasonably assess the following: 1) presence and severity of all carious lesions; 2) tooth surface cavitation status; 3) caries risk; and 4) outcome probabilities for treatment regimens.

Several systematic reviews of the scientific literature (English text) between 1980 and 2000 were made to answer the following question: What are the best methods available for the prevention of coronal dental caries initiation in permanent teeth as a function of caries risk? A search on the subject of decision-making based on caries management resulted in 1,247 publications. By limiting the search to humans and the English language, the number was reduced to 973. By limiting the age range to subjects thirteen years and older, the number of references decreased to 397. By eliminating root caries in the search, the number of relevant publications decreased further. Another search on chemotherapeutic agents for caries management [(chlorhexidine OR fluoride) AND caries hedge AND (therapy OR risk)] produced 552 articles, which were reduced in number by excluding root caries. A third search, which was focused on sealants or combined treatments such as fluoride and sealant yielded 394 articles after root caries was excluded.

To competently answer the assigned question, the following additional information is required: 1) probability of lesion initiation or progression as a function of caries risk; 2) probability of tooth surface cavitation over a specified period of time; 3) best treatment methods to arrest active lesions and potentially to remineralize teeth with noncavitated lesions as a function of patient risk; 4) lesion depth at which a restoration should be placed (threshold for surgical intervention) for a patient’s initial risk level; and 5) the probable utility of noninvasive disease-controlling regimens compared with the probable utility of nontreatment and restorative treatment options.

The page limitation for this article precludes a detailed discussion of decision analysis such as simple decision-tree calculations and the potential use of decision-support systems. The latter option incorporates caries susceptibility factors and treatment outcome probabilities into computer software designed to simplify and standardize the clinical decision-making process. The following sections will briefly summarize scientific evidence on the principal treatment options for caries management in coronal areas of permanent teeth.

Pit and Fissure Sealants

The majority of sealant studies were performed on children less than thirteen years of age. Selwitz et al. evaluated the combined use of sealants and fluoride over a four-year period for prevention of caries in a group of fourteen-to-seventeen-year-old children compared with the use of fluoride alone. A group that received school-based fluoride and dental sealants experienced a 34.6 percent lower DMFS score (4.07) compared with that of the fluoride only group (6.22). This result indicates that pit and fissure sealant provides additional caries-preventive benefit compared with fluoride alone. However, only 71.8 percent of the sealants were completely retained over the four-year period.
A meta-analysis study of sealant effectiveness was reported for children between the ages of five and fourteen. For the studies considered, the effectiveness of sealants increased for populations residing in fluoridated water communities (82.7 percent) compared with the lower effectiveness (72.3 percent) for populations associated with nonfluoridated communities.

In a ten-year study, visual and radiographic evaluations were performed on bonded and sealed composite restorations (CS/C) placed directly over frank, cavitated lesions extending into dentin. Control treatments included caries tissue removal and placement of either sealed amalgam (AS) or nonsealed amalgam (AU) restorations. This study involved 123 subjects with a median age of twenty-three years (ranging from eight to fifty-two years). Over the ten-year period, secondary caries occurred in only one CS/C case (1.2 percent), one AS site (2.3 percent) and seven AU sites (17.1 percent). I computed these values as the worst-case scenario, that is, assuming that these lesions were present in the subjects seen at the ten-year recall exam. None of the radiolucencies progressed over the ten-year period. The results of this study provide fair evidence that sealants placed only one time over cavitated occlusal carious lesions, with no subsequent rescycling treatment, can prevent progression of caries in those sites.

Chemotherapeutic Agents for Prevention and Arrest of Carious Lesions in High-Risk Subjects

The evidence for fluoride efficacy clearly indicates that no professionally applied fluoride-releasing product or restorative material has shown the ability to consistently prevent caries in high-risk individuals. Similarly, chlorhexidine treatment alone has not been highly effective in preventing caries in the absence of fluoride. A meta-analysis of clinical studies on the use of chlorhexidine for prevention of caries in eleven- to fifteen-year-old children with S. mutans levels > 2.5 x 10⁵/mL saliva indicates that the caries-inhibiting effect of chlorhexidine is 46 percent.

Gisselsson, Birkhead, and Björn reported that, after three years of professional flossing with 1 percent chlorhexidine gel applications to the teeth of twelve-year-olds four times per year, the mean approximal caries increment was 2.5 compared with 4.3 for the control subjects (p ≤ 0.05) who received a placebo gel without flossing over the same period.

Zickert et al. reported a statistically significant difference between the mean caries increment over three years (DS = 4.2) of a test group of thirteen- to fourteen-year-old children with S. mutans/mL saliva who received oral hygiene and dietary instructions and an application of one percent chlorhexidine gluconate gel for five minutes after tooth cleaning for fourteen days compared with the control group (DS = 9.6). Children in the control group with S. mutans/mL saliva did not receive either chlorhexidine or a placebo gel. For the highest-risk children, that is, those with 10⁶ CFU/mL initially, the mean DS increment after three years was 3.9 for the test group and 20.8 for the control group.

Luoma et al. reported that caries management therapies in extremely high-risk children (DMFS scores from 27.4 to 31.4), ranging in age from eleven to fifteen years of age, revealed significant differences in mean DMFS increment among groups receiving a two-minute daily rinse in school (200 days per year) and three times per day of daily toothbrushing during weekends of one of the following: 1) no treatment control group (ΔDMFS = 6.30); 2) placebo solution (ΔDMFS = 5.08); 3) 0.044 percent NaF (ΔDMFS = 4.31); and 4) 0.05 percent chlorhexidine gluconate plus 0.044 percent NaF (ΔDMFS = 2.9). The mean differences were significant between Group 4 and the control group (p ≤ 0.001) and the placebo group (p ≤ 0.05), as well as between Group 3 and the control group. These latter two studies provide fair supporting evidence for the use of high frequency and low doses of fluoride and chlorhexidine solutions for very high-risk patients.

Fair evidence exists to establish a link between the efficacy of chlorhexidine gel and a reduction in caries increment. Two studies suggest that periodic professional flossing four times a year with a 1 percent chlorhexidine gel may be more effective in reducing approximal lesions than mouthrinsing with chlorhexidine solution. Further studies are needed to confirm the results of these two studies and the relative caries risk level above which this therapy is effective. All of the subjects in these two studies were between the ages of eleven and fifteen years.

A systematic search of the literature has found no randomized, controlled clinical trial studies of chlorhexidine efficacy for control of caries in adult subjects that are at least two years in duration. Three relevant articles were found for adult subjects, but these were associated with irradiated subjects.
Threshold for Surgical Intervention

We can justify a delay in restorative treatment of enamel lesions in the inner half of enamel and even slightly into dentin on the basis that caries progression in moderate-risk and high-risk patients through enamel is slow.\textsuperscript{9} Caries progression has been decreasing over recent decades and is slower in patients who have received regular fluoride treatment or who consume fluoridated water.\textsuperscript{10,11} Progression times through enamel may take from six to eight years.\textsuperscript{12-16} Since many enamel lesions remain unchanged or progress very slowly over long periods and because progression rates through dentin also may be comparably slow, there is adequate time to apply infection control and monitoring procedures to assess caries risk and lesion activity status over extended periods of time.\textsuperscript{17}

To minimize variability in decision-making and to optimize cost-effectiveness and the cost-benefit parameters of care, the strongest evidence on treatment regimens must be used. Summarized in Table 1 is a comparative assessment of the strength of evidence of various treatment options for caries management in coronal areas of permanent teeth for adolescent and adult patients. As can be clearly seen, the strength and quality of data-supporting management options for adult patients are very poor. This deficiency is associated in part with the failure to monitor treatment efficacy as a function of individual risk over time.

For teeth with cavitated surfaces, a restoration should be placed after initial efforts to reduce caries risk have been taken. As shown in Table 2, all tooth surfaces with cavitated lesions should be restored since they cannot be reliably remineralized and maintained free of plaque. For teeth with approximal lesions, the surface integrity cannot readily be determined unless the teeth are separated or the lesion severity is sufficiently great (middle third of dentin, D2, or inner third of dentin, D3) that the probability of cavitation is very high.\textsuperscript{18} The results of these studies indicate that approximately 60 percent of approximal tooth surfaces with radiolucencies extending into the outer half of dentin are not cavitated.\textsuperscript{18} However, these results do not agree well with those of Akpata et al. who reported that only 20.9 percent of the surfaces were not cavitated when the lesions were found in the outer half of dentin.\textsuperscript{19} This difference could have been explained if the individual subjects had been assessed for risk at baseline and over the course of the study prior to cavitation assessment.

Foster investigated the proportion of approximal carious lesions extending up to 1 mm into dentin that progressed over a three-year period.\textsuperscript{20} After thirty-six months, lesions that extended over 0.5 mm and up to 1 mm into the dentin were significantly more likely to have progressed (92 percent) than shallower lesions that extended up to only 0.5 mm into dentin (50 percent). These results sug-

<p>| Table 1. Strength and quality of evidence on efficacy of caries management treatment options for high-risk patients (0 = none, 1 = minimal, 2 = fair; 3 = good) |</p>
<table>
<thead>
<tr>
<th>Treatment Option</th>
<th>Adolescents</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluoride toothpaste</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Fluoride tablets, mouthrinses, or combined fluoride sources</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Fluoride varnish only</td>
<td>2</td>
<td>0</td>
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<tr>
<td>Sealant only</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Chlorhexidine only</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chlorhexidine plus fluoride</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sealant plus chlorhexidine</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sealant plus fluoride</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Sealant plus chlorhexidine and fluoride</td>
<td>0</td>
<td>0</td>
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</tbody>
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| Table 2. Treatment options based on caries risk, lesion severity, and surface integrity |
|---------------------------------------------|---------------------------------------------|
| Low Risk                                    | Moderate Risk                               | High Risk                                   | High Risk                                   |
| Lesion Severity                             | E1, E2                                     | E2, D1                                     | D1, D2, D3                                 |
| Surface Integrity                           | Noncavitated or Questionable                | Questionable                               | Cavitated                                   |
| Caries Activity                             | Inactive or questionable                    | Active, progressing slowly                 | Active, progressing rapidly                |
| Treatment Option                            | Diet and oral hygiene control; monitor for new lesions at 6- to 12-mo recall periods | Diet and oral hygiene control; professional and home flossing with 1% CHX; periodic F; monitor at 6-mo recall periods until shifted to low risk (or < 2.5 x 10^5 CFU/mL) | Diet and oral hygiene control; professional and home flossing with 1% CHX; seal pits and fissures; restore all cavitated surfaces; daily F; monitor at 3- to 6-mo recall periods until shifted to low risk (< 2.5 x 10^5 CFU S. mutans/mL) |
|                                            |                                            |                                            |                                            |

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gest that operative intervention be considered for approximal lesions that extend deeper than 0.5 mm into the dentin, while preventive treatment and re-assessment may be considered for shallower lesions.

Professional flossing with chlorhexidine gel should be performed at least four times per year to ensure adequate reduction of S. mutans levels. Since chlorhexidine is not effective against lactobacilli, plaque removal and diet modification may reduce the level of lactobacilli and the probability for lesion progression. In addition, fluoride therapy should be closely linked with the use of chlorhexidine for high-risk patients. Little additional benefit is likely to be realized by treating moderate-risk or low-risk patients with chlorhexidine, although fluoride therapy is still advised for moderate-risk patients until they are shifted to a low-risk level.

Clearly, monitoring for positive and negative changes in the activity status of the disease is the most important aspect of caries management. If the caries process is active, early interventions to arrest the process will reduce the probability of cavitation and potential restorations. Monitoring at intervals determined by risk also will ensure that the prescribed treatment benefits will be sustained and that low-risk patients will not be overtreated. Since the strength and quality of evidence for most treatment options are relatively poor overall (Table 1), doses and frequencies of therapeutic agents must be adjusted periodically, depending on whether the targeted outcomes are achieved or not.

REFERENCES