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RESEARCH ARTICLE

The Effect of Rubber Cup Polishing on Root Surface Contour

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Abstract

Purpose: The purpose of this study was to investigate the effects of rubber cup polishing on root surface contour.

Methods: Five human teeth were mounted. Three root trunk surfaces of each tooth were polished with a different abrasive. Abrasives included toothpaste, fine prophy paste, and coarse prophy paste. Each polishing was 5 seconds in length. Each set comprised 15 repetitions. Photographs were taken before treatment and after 3 polishing sets, for a total of 45 polishings. Photograph booklets were created with pre-treatment and post-treatment photographs of each tooth. Calibrated evaluators noted presence or absence of visual contour loss. Average pre-treatment scores were compared to average post-treatment scores using a one-tailed t-test ($p<0.05$).

Results: No significant loss of contour was noted between pre-treatment and 15 polishing repetitions for toothpaste and fine prophy paste. Significant loss of contour was noted between pre-treatment and 30 and 45 polishing repetitions for toothpaste and fine prophy paste and between pre-treatment and all polishing sets for coarse prophy paste.

Conclusion: Coarse prophy paste produces visually apparent abrasion of root surfaces in as few as 15 polishings. Toothpaste and fine prophy paste also cause visually apparent abrasion over time. Lesions produced by rubber cup polishing may resemble those attributed to abfraction and further research is indicated to determine if polishing could be indicated as a cause of these type of lesions. Clinicians should consider the effects of rubber cup polishing on root surfaces when making clinical decisions on stain removal.

Keywords: Abfraction, Abrasion, Polish, Non-carious cervical lesions, NCCL, tooth root

Introduction

Rubber-cup polishing is a standard procedure in the dental office. Evidence shows polishing under standard clinical conditions during a dental prophylaxis does not result in clinically significant loss of sound enamel [1]. However, cementum and dentin are not as hard as enamel, resulting in abrasion from rubber cup polishing [1-3]. Exposed root surfaces often become stained and may be subjected to polishing for stain removal during dental prophylaxes. Additionally, inadvertent polishing of exposed root surfaces may occur if the rubber cup extends beyond the anatomical crown at the cemento-enamel junction [1,4]. Further investigation is necessary to evaluate effect of various abrasives on root surfaces over time. This study investigates presence or absence of visually apparent abrasive effects on root tissue from rubber cup polishing. Visual effects were chosen to demonstrate clinical relevance for application in dental practice.

Methods and Materials

The University of Alaska Anchorage Institutional Review Board determined this study was not human subject research. Teeth were collected from local dental offices following extraction for dental purposes and were steam sterilized prior to transportation. Five specimens were selected, discarding those with obvious defects on root surfaces. Teeth were mounted as described previously [1] with the exception that each tooth was placed in a separate block to enable polishing access to multiple surfaces (buccal, lingual, mesial, distal) and each tooth was extruded as much as possible for root trunk access. Pretreatment photographs and radiographs were obtained for each surface of each specimen (described later). Three random surfaces of each root trunk were polished with a different type of paste. Polishing treatments included 1) coarse prophylaxis paste 2) fine grit prophylaxis paste (coarse and fine NUPRO®Prophylaxis Paste with Fluoride, DENTSPLY International Inc., Milford, DE), and 3) toothpaste (Crest® Cavity Protection, regular paste, Proctor & Gamble, Cincinnati, OH). Pastes were applied using soft prophy cups (DENSCO® Prophy Cups, soft, blue, ribbed, Water Pik, Inc., Fort Collins, CO). Polishing equipment and parameters were the same as previously described [1]. Each surface was polished for five seconds, then paste was reapplied. The polishing cup was held stationary on the tooth while rotating. Each specimen was rinsed and photographed after each of three sets of 15 polishings for a total of 45 treatments per surface, on three surfaces of each of five teeth.

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Pre-treatment photographs were taken as were post-treatment photographs after each set of 15 polishings (15-30-45). Because of variances with tooth surface anatomy and lighting effects, photographs were exposed from multiple angles to obtain optimal visualization of each surface. Specimens were placed on a template to ensure specific angulation was accurately replicated in subsequent photographs. A tripod-mounted, Nikon D-5000 camera was used with the following settings: ISO 1600; Shutter 1/13; F-20 and Long F-32 manual setting (Figure 1).

An evaluation booklet was created with a separate page for each treated surface of each tooth. A pre-treatment photograph was shown on the left side of the page, along with four additional comparison photographs, one pretreatment control, and one each at 15, 30, and 45 polishings. These were randomly ordered on the right side of the page. Because other surfaces were also visible on photographs, the surface being evaluated was outlined with a red square (Figure 2). Photographs were chosen that best displayed the treated surface based on visualization and lighting on the given surface. The same angulation was used for all photographs of a particular surface once it was determined to be optimal. Each toothpaste and fine prophy paste treatment was displayed once in the booklet while each coarse prophy paste treatment was displayed twice, from two opposite angles. This provided 20 pages of photographs in the booklet (4 surface views x 5 teeth = 20 pages).

Twenty dental hygienists evaluated the photographs. Evaluators were blinded to the comparison photographs, i.e. unaware which were treatment or controls. All were provided instruction on evaluation and were calibrated with test photographs prior to formal evaluation of specimen photographs. Each photograph was evaluated with two choices available: 1) No or questionable loss of contour and 2) Obvious loss of contour. This evaluation of lesions is similar to a tooth wear index used to measure non-carious cervical lesions, but quantification was not included because the focus of this study was simply documentation of presence or absence of abrasive damage [5].

Figure 1: Camera and template set up for photographs of mounted teeth.

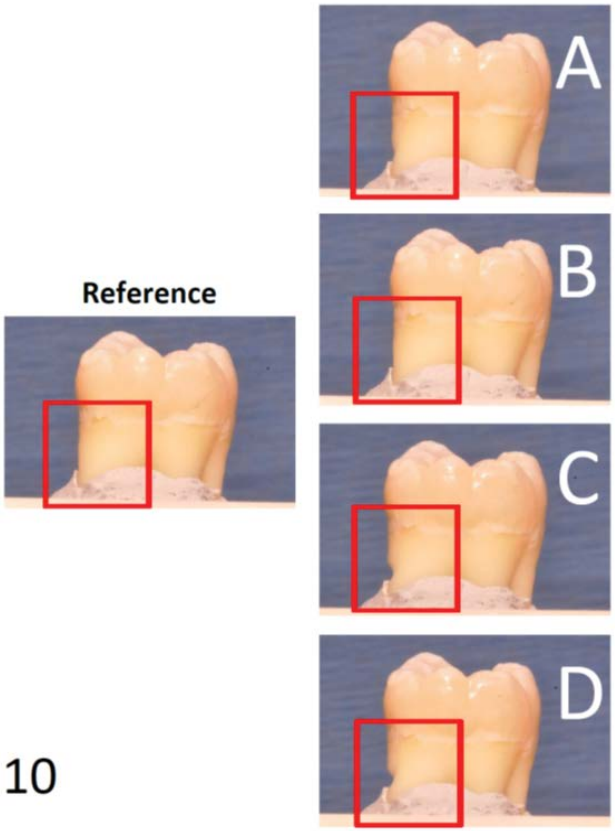

Figure 2: Sample page from photograph booklet.

Evaluators were instructed to note only visible quantitative change (e.g. not color change) on the designated surface on each page for each photograph. Each evaluation choice was assigned a point value. No or questionable loss of contour = 0 points; obvious loss of contour = 1 point. Points for each photograph were averaged. Points for each treatment type over each interval level were then averaged and compared against its respective pretreatment group using a 1-tailed t-test [6]. Statistical significance was set at $p < 0.05$.

Results

For both toothpaste and fine prophy paste, no significant difference ($p < 0.05$) in contour was noted between pretreatment surfaces and post-treatment surfaces after 15 polishing sets. For 30 and 45 repetitions and all coarse paste treatments, significant ($p < 0.05$) loss of contour was found between pretreated and treated surfaces. Results from the two coarse prophylaxis treatment views were similar (Table 1 and Figures 3, 4, 5, and 6).

Table 1: Average evaluator scores of each treatment group for each polishing interval. Possible score range is 0.00 to 1.00. ' indicates significant difference between pretreatment and treatment scores.

	0x (Pre-Tx)	15x	30x	45x
Toothpaste Avg	0.05 (+/- 0.039)	0.15 (+/- 0.045)	0.2' (+/- 0.042)	0.21' (+/- 0.053)
Fine Paste Avg	0.1 (+/- 0.032)	0.43 (+/- 0.166)	0.43' (+/- 0.145)	0.48' (+/- 0.175)
Coarse Paste 1 Avg	0.06 (+/- 0.037)	0.59' (+/- 0.130)	0.71' (+/-0.159)	0.82' (+/- 0.155)
Coarse Paste 2 Avg	0.04 (+/- 0.019)	0.62' (+/- 0.180)	0.69' (+/- 0.198)	0.82' (+/- 0.180)

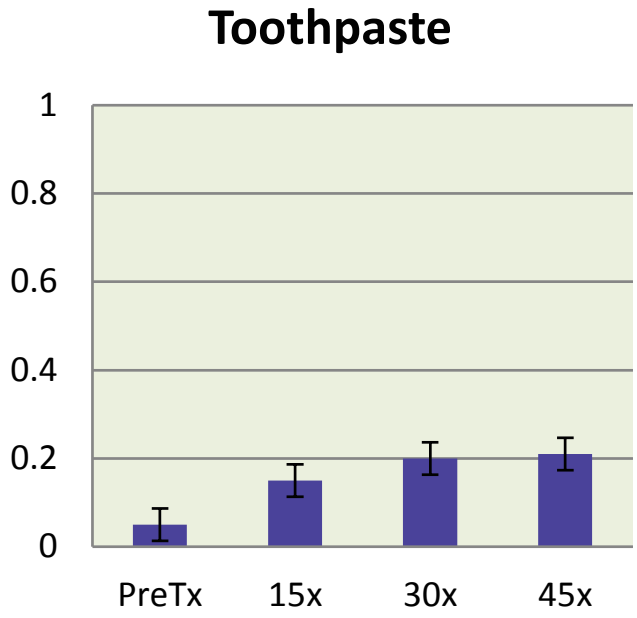

Figure 3: Average scores from toothpaste treatment group.

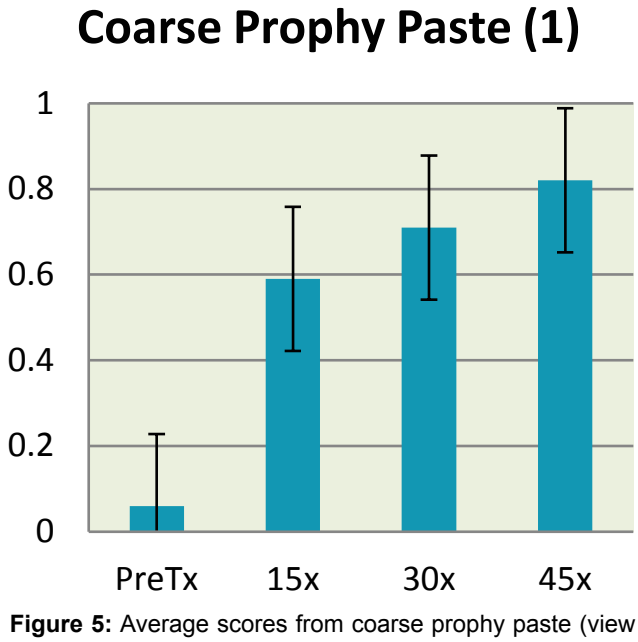

Figure 5: Average scores from coarse prophy paste (view 1) group.

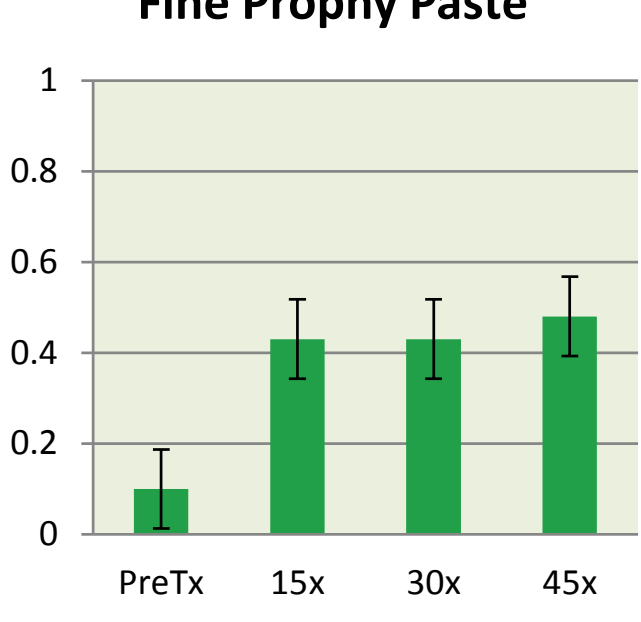

Figure 4: Average scores from fine prophy paste treatment group.

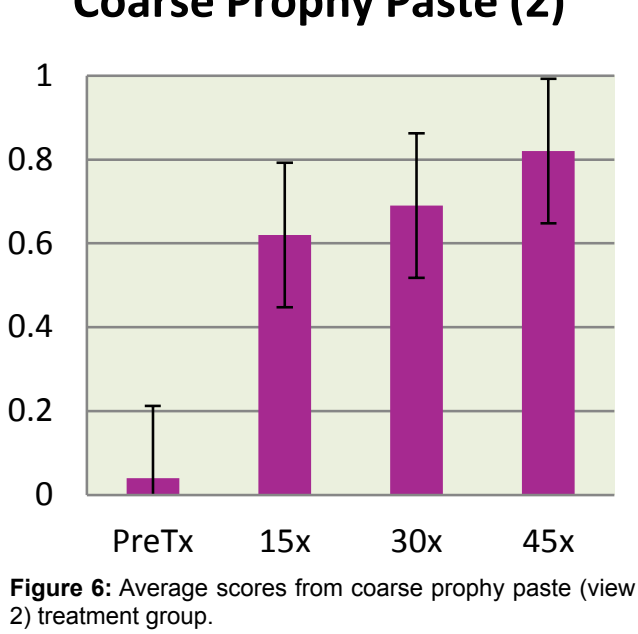

Figure 6: Average scores from coarse prophy paste (view 2) treatment group.

Discussion

Previous research on rubber cup polishing on enamel revealed that inadvertent polishing on root surfaces can cause visible abrasion [1]. More research was indicated to determine the effect of various abrasives over time on root surfaces. This study demonstrates visible abrasion is apparent using toothpaste or fine prophy paste after 30 five-second polishings, or after 15 five-second polishings with coarse prophy paste (Figure 7). Some evaluators detected abrasion at an earlier polishing interval than other evaluators. More evaluators noted loss of contour with increased repetitions and with increased abrasiveness of the polishing agent. This gradual increase in point scores indicated progression of abrasion until it was obvious to all evaluators at a maximum score of 1. Because results from five subject teeth were grouped together and contour loss varied between individual teeth, no group averaged the maximum score possible (1), though some surfaces on individual teeth did.

Figures 3, 4, 5, and 6 graphically represent results of each group. When comparing treatment with pre-treatment scores, significant score differences between pretreatment and 15 polishing sets appear to exist in all treatments; however variance within the toothpaste and fine groups made those differences statistically insignificant.

Toothpaste was used to represent an agent with little to no abrasivity. In retrospect, it would have been helpful to also use a prophy cup without abrasive to determine if the toothpaste alone was a factor in the abrasion or if the actual prophy cup could also cause abrasion. Though the method did not allow for detection of abrasion outside of 15 polishing sets, it is clear that polishing root surfaces with common over the counter toothpaste causes loss of dental tissue in a relative short period of time. The more abrasive the agent, the more significant the abrasion becomes. (Table 1; Figures 8, 9, and 10)

Considering the cumulative nature of abrasive damage to dental tissues and the body's inability to naturally restore it, this study's results indicate that coarse prophy paste is contra-

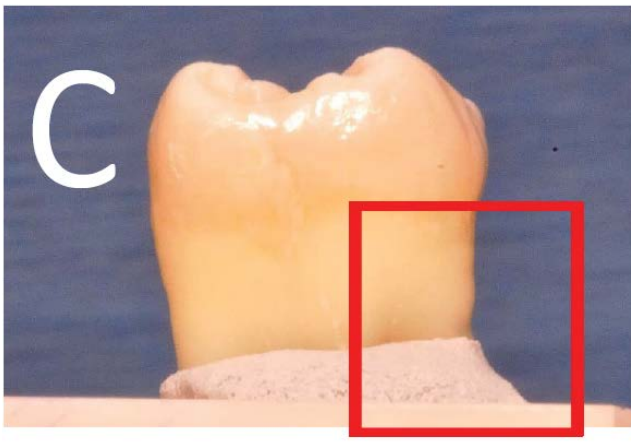

Figure 7: Tooth surface after 15 five-second polishing with coarse prophy paste.

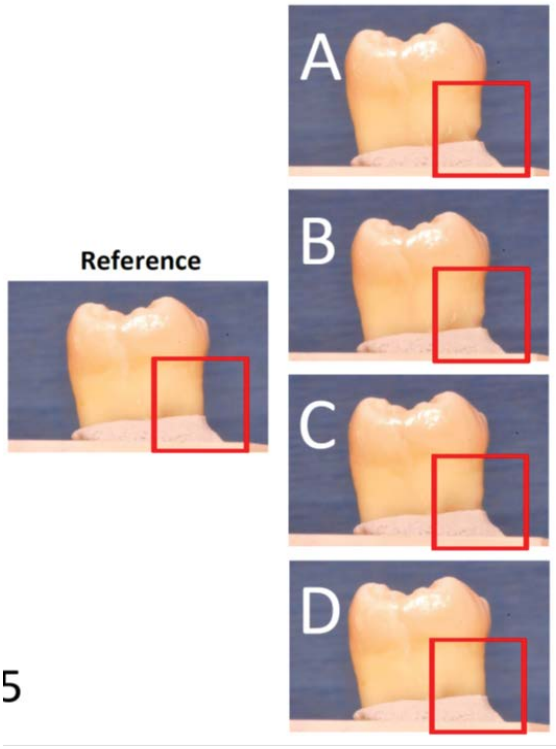

Figure 8: Coarse prophy paste treatment that demonstrates increased abrasion with additional polishings. Photograph D is pre-treatment, C is after 15 polishings, B is after 30 polishings, and A is after 45 polishings. Abrasion from coarse prophy paste appears similar to abfraction lesions.

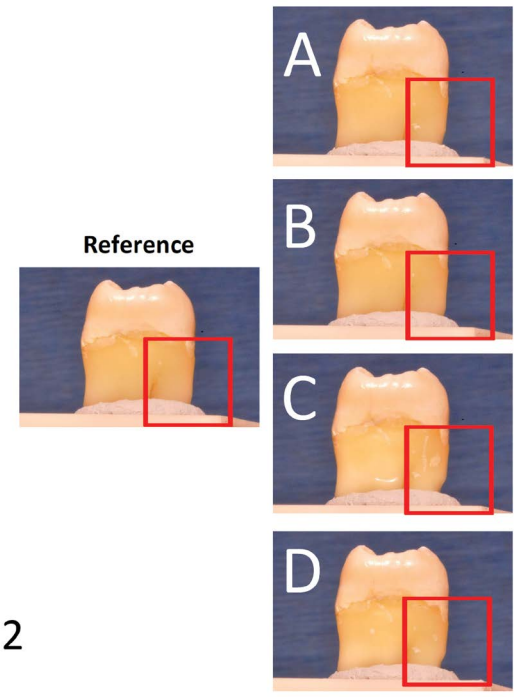

Figure 9: Coarse prophy paste treatment that demonstrates increased abrasion with additional polishings. Photograph B is pre-treatment, A is after 15 polishings, D is after 30 polishings, and C is after 45 polishings. Abrasion from coarse prophy paste appears similar to abfraction lesions.

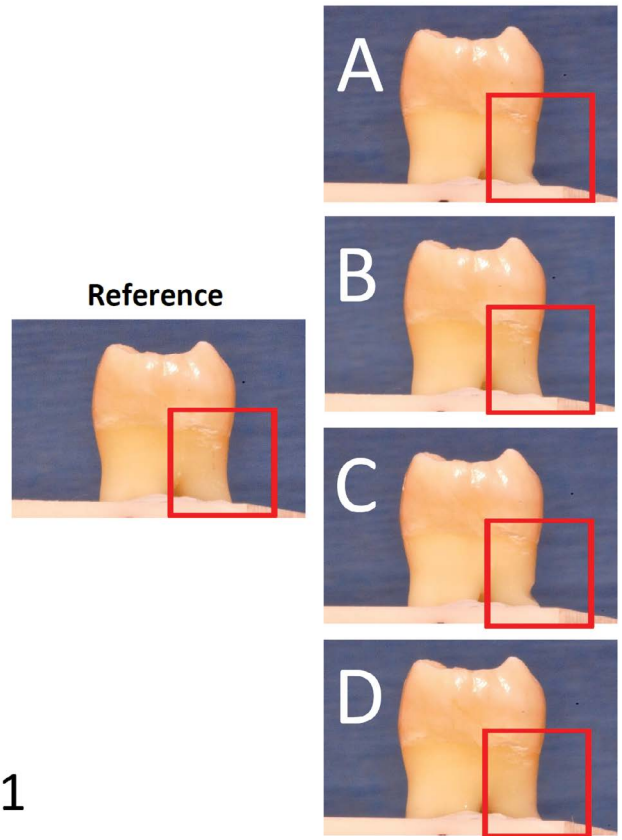

Figure 10: Coarse prophy paste treatment that demonstrates increased abrasion with additional polishings. Photograph B is pre-treatment, D is after 15 polishings, A is after 30 polishings, and C is after 45 polishings. Abrasion from coarse prophy paste appears similar to abfraction lesions.

indicated on root surfaces and even fine paste or toothpaste should be used with extreme caution, if at all. This likely will require clinicians to reconsider their treatment choices when dealing with stained root surfaces; however, identifying choices that result in stain removal without damaging root tissue may be challenging. Hand instrumentation, mechanized debridement, air polishing, and rubber-cup polishing all remove some amount of root structure [1,7,8].

The lesions produced by the rubber cup polish on root surfaces raise an additional concern. Inadvertent uneven pressure on the rubber cup can produce excessive abrasion. In this study an exact 90' angle of prophy cup to tooth surface was desired [9] but it was not quite achieved due to the design of the polishing apparatus. This caused uneven abrasion from pressure of the rubber cup rim. While this uneven pressure was unintentional, it is a technique error that can occur in the clinical situation. These lesions, though located directly on the root surface because of the intentional polishing of the root surface, resemble abfraction lesions commonly found near the CEJ. (Figures 8, 9 and 10) A previous study on rubber cup polishing on enamel demonstrated similar lesions at the CEJ from occasional slippage onto the root surface [1].

Traditional polishing technique includes sufficient pressure to flare the edges of the cup to reach slightly under the gingival margin [9]. Is it possible that the edge of the polishing cup reaches past the CEJ and abrades the root surface, especially if uneven pressure is applied to the cup? If so, could this procedure result in non-carious cervical lesions (NCCLs), "defined as a loss of hard dental tissue near the cementoenamel junction, usually on the buccal surfaces of teeth" [10] on vulnerable teeth on some patients." If clinicians are able to perform this technique more thoroughly and/or with more pressure on buccal surfaces than lingual surfaces due to ease of access, this could explain, at least in part, some lesions that have previously been attributed to occlusal-force abfraction. Recent studies [11-14] suggest NCCLs have multifactorial causes. The question might be raised: Could rubber cup polishing be a contributing factor in the development of these lesions?

Conclusion

Previous research revealed abrasion of root surfaces from inadvertent slipping of the rubber cup off the enamel onto root surfaces [1]. Additional research was indicated to determine the effect of various polishing agents over time on root surfaces because clinicians often polish root surfaces to remove stain. This study demonstrates visible abrasion is apparent using toothpaste or fine prophy paste after 30 five-second polishings, or after 15 five-second polishings with coarse prophy paste (Figure 7).

The results from this study presents an ethical dilemma for dental hygienists treating patients with stained root surfaces. Hygienists are taught to remove stain, especially in visible areas for esthetics. When a patient presents with root staining, clinicians may select hand instruments, power scalers, air polishing, and/or rubber cup polishing, or a combination of methods to remove stain. All of these techniques have been proven to remove root structure [1,7,8]. Some air polishing powders are less abrasive, such as glycine or erythritol, but those are recommended for biofilm removal with no current evidence supporting stain removal [15-17]. A non-abrasive method of stain removal on root surfaces is needed for prophylaxis and periodontal maintenance appointment procedures.

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