Reduction of Bleeding On Probing With Oral-Care Products

Conrad W. Chapek, DDS
Private Practice
Arlington Heights, Illinois

Omer K. Reed, DDS
Private Practice
Phoenix, Arizona

Perry A. Ratcliff, DDS
Emeritus Professor
University of California at San Francisco
School of Dentistry
San Francisco, California

Bleeding on probing is an important indicator for detecting the presence of periodontal disease activity. Gingival bleeding occurs when there is a break in the continuity of the epithelium. This retrospective study compared the number of bleeding on probing sites that measured 4 mm or more with the use vs nonuse of RetarDENT®,[a] toothpaste and RetarDEX®,[a] oral rinse, chlorine dioxide (ClO_2)/phosphate oral-care products.

A previous study by the authors demonstrated that in 2,085 periodontal defects measuring at least 4 mm were reduced to less than 3 mm (or by 67%) with a mean of 3 to 4 months after using RetarDENT® toothpaste and RetarDEX® oral rinse.[1] Bleeding on probing is accepted as an important indicator to detect the presence of periodontal disease activity.[2-4]

There are conflicting reports about the influence of oxygen on the integrity of the gingival epithelium. Hirsch questioned the value of oxygen while Kaiser and Orban found it to be beneficial.[5-8] The purpose of this study was to determine if the use of a high redox capacity ClO_2/phosphate-based toothpaste and oral rinse would provide a change in bleeding on probing in patients receiving routine prophylaxis in a recare practice.

Review of the Literature

When the epithelium is contiguous, it is impossible to have overt bleeding. However, if the epithelium is thin because of underlying inflammation, a fracture of this continuity can be achieved easily. Thus, probing may be sufficiently traumatic to initiate overt hemorrhage.

It has been shown by Rizzo,[9] Ng and Tonzetich,[10] and Gaffar[11] that, in the presence of intact epithelium, bacterial antigens do not cross into the underlying connective tissue unless a thiol compound is present to facilitate the epithelial penetration. Therefore, it is important that the continuity of the sulcular and marginal epithelial covering be kept intact and with sufficient thickness to generate an adequate barrier to bacterial antigens. Thus, at the current state of knowledge, an intact epithelial barrier in the absence of thiols should intercept and prevent the antigenic initiation of gingivitis and periodontitis.

Bleeding on probing and its relation to the degree of inflammation and bleeding tendency has been reviewed by Anderson and Smith.[12] At the clinical examination during recare prophylaxis visits, bleeding scores should be recorded at the same time as probe and plaque scores.

It has been reported that bleeding on probing can be an earlier sign of gingivitis than changes in color or swelling. Also, there is a significantly greater number of surfaces that bleed on probing compared to those that change color only or exhibit combined color change plus bleeding on probing.[13] Other investigators have indicated that bleeding preceded gingival color changes. In a study of 738 gingival sites that had a healthy appearance and no bleeding on probing, 264 gingival sites bled on probing after 17 days without brushing, even though they appeared healthy and had no color change. It was concluded that bleeding was a leading indicator of marginal gingivitis.[2]

Caton et al[14] reported a study of 26 patients, which showed that probe penetration was greater in the presence of viable inflammation, but not with bleeding on probing alone. Van der Velden[15] reported a more accurate location of the tip of the probe in nonbleeding

[a] Rowpar Pharmaceuticals, Inc, Scottsdale, AZ 85260.

Table 1—Means Before and After Product Use

	Range	Total # Bleeding Sites	Mean # Bleeding Sites	Mean # Months Between Visits	Mean % Change	Paired *t*-test
Baseline visit	39 to 0	239	21.73		NS*	
Second visit (products prescribed)	44 to 5	256	23.27	7.05	7.09%	P = NS*
Third visit (after product use)	16 to 0	72	6.55	6.91	71.85%	P = <0.01

*Not significant

Table 2—Mean Results From Patients Who Discontinued Product Use

	Mean # Sites	Mean # Months	Mean % Increase	Mean % Decrease	Paired *t*-test
1st Evaluation (baseline)	22				NS*
2nd Evaluation (products dispensed)	34	7.1	55%		*P* = <7.8
3rd Evaluation (after product use)	7	6.8		79%	*P* = <0.01
4th Evaluation (after discontinuing products—more product dispensed)	18	3.3	157%		*P* = <0.01
5th Evaluation (after product use)	10	3.5		44%	*P* = <0.01

*Not significant

areas vs those that bled. Abbas et al[16] reported that increased bleeding reduced reproducibility of pocket depth measurements. Bleeding pockets have deeper probe scores than nonbleeding pockets.[15]

Increased bleeding has been correlated with a risk of attachment loss at specific sites during the maintenance phase of periodontal care.[17] This observation was based on 55 patients with 1,054 periodontal defects who had been treated for advanced periodontal disease with a 3- to 5-month prophylaxis recall program for 4 years. Patients with 16% or more sites that bled on probing had a greater chance of losing attachment. In contrast, a study by Proye et al[18] reported a gain of attachment level paralleling the cessation of bleeding on probing.

Biopsies of areas with gingival bleeding showed that there were larger areas of inflamed connective tissue when compared with specimens that did not bleed.[19] With differences reported of bleeding vs nonbleeding areas, it was postulated that this could be the result of increased capillary fragility or permeability.[20] Biopsy specimens showed that inflammatory infiltrate characterized by plasma cells was more evident in areas with clinical bleeding on probing when compared to nonbleeding areas. The bleeding areas had a higher level of connective tissue inflammatory response as judged by cellular infiltrate vs the nonbleeding areas that had inflammatory cells located only adjacent to the crevicular epithelium.[21]

Chutter and Ratcliff, using C^{14} labeled sucrose as a marker, documented the ability of low molecular weight compounds to diffuse throughout plaque from coronal plaque into the subgingival plaque located within the pocket area (unpublished data, 1994). This would facilitate salivary-borne antigens and thiols moving from saliva into coronal plaque and then into intrasulcular plaque. Thus, sulcular penetration of thiol permeation factors could deliver bacterial toxins and lipopolysaccharide into the sulcular space. Also, this modality could deliver therapeutic substances into the locus of the disease process.

Materials and Methods

Eleven patients were selected with a total of 239 bleeding sites who had a history of continuous recare by the same hygienist in the same practice throughout this study. Eight were compliant and three discontinued product use at the completion of the main study. At each prophylaxis recare visit, no change in treatment was provided other than the addition of the test products.

At the baseline visit, the patients were examined and their dental and medical histories were updated. Bleeding on probing scores for the 11 patients were recorded at each recare prophylaxis visit with

the same technique by the same hygienist. Each patient was used as his or her own control by establishing the change between the baseline visit and the first subsequent visit after which the test products were dispensed.

The bleeding on probing scores of the 11 patients were recorded at 3 different intervals: (1) at baseline; (2) at the date the products were given to the patient; and (3) at the next visit after the test oral-care products had been used.

The patients were instructed to brush and rinse twice daily and to use the toothpaste first because the activated ClO_2 reacts readily with salivary glycoproteins. Thus, more active ingredients would be available from the rinse when preceded by the dentifrice. Also, unpublished data by Armitage and Wang indicated that the test toothpaste alone will reduce bleeding scores even in the presence of coronal plaque.

Three of the patients with 66 bleeding sites at baseline discontinued use of the prescribed oral-care products after the third visit.

Bleeding scores for these three cases were reported at five different evaluation times by the hygienist: (1) at baseline; (2) at the second recare visit when the oral-care products were dispensed; (3) at a third evaluation after the oral-care products were used; (4) at a fourth evaluation after the patient had discontinued use of the products, had regressed, and additional products were dispensed; and (5) at the fifth evaluation after the patient had again used the test products.

Statistical analysis of data was performed using the Student's *t*-test as well as z scores for each of the four intervals between the five bleeding-on-probing evaluation visits.

Table 3—Statistical Evaluation by Student's *t*-Test*

Standard deviations were estimated by dividing the range of observed sites by four

1st Sample Size	239	- Baseline visit
2nd Sample Size	256	- Second visit: Put on products
1st Mean	21.7	
2nd Mean	23.3	
1st Standard Deviation	9.8	
2nd Standard Deviation	9.8	
t Score	1.763	
Significance Level	92.2%	- *P* = >7.8, NS**
1st Sample Size	256	- Second visit: Put on products
2nd Sample Size	72	- Third visit
1st Mean	23.3	
2nd Mean	6.5	
1st Standard Deviation	9.8	
2nd Standard Deviation	4.0	
t Score	21.713	
Significance Level	99.9%	- *P* = <0.01
1st Sample Size	72	- Third visit
2nd Sample Size	54	- Fourth visit (3 patients only)
1st Mean	6.5	
2nd Mean	18.0	
1st Standard Deviation	4.0	
2nd Standard Deviation	3.5	
t Score	17.094	
Significance Level	99.9%	- *P* = <0.01
1st Sample Size	54	- Fourth visit (3 patients only)
2nd Sample Size	31	- Fifth visit (3 patients only)
1st Mean	18.0	
2nd Mean	10.3	
1st Standard Deviation	3.5	
2nd Standard Deviation	3.5	
t Score	9.725	
Significance Level	99.9%	- *P* = <0.01

*Statistical analysis performed by Analytical Computer Services, Scottsdale, Ariz.
**Not significant

Results

At the beginning of the study, 239 bleeding sites with probe scores of 4 mm or more were observed in 11 patients with a mean of 21.73 sites per patient. At the second recare visit, after a mean of 7.05 months, the total number of bleeding sites had increased to 256, a mean of 23.27 per patient. There was a 7.09% increase in sites demonstrating bleeding on probing between baseline and the second visit (not statistically significant). At the second recare visit, the two test products, RetarDENT® toothpaste and RetarDEX® oral rinse, were given to each patient.

After a mean of 6.9 months between the second and third recare prophylaxis visits, the hygienist rescored the mouth, recording all bleeding sites. After the test toothpaste and oral rinse were used twice daily, there were 72 bleeding sites compared to the original 256 sites before the activated ClO_2/phosphate products were dis-

Table 4—Evaluation of Data by *z* Scores*

Number of patients studied: 11		
Sample Size	567	Total sites
1st Proportion	42.2	First score
2nd Proportion	45.2	Baseline: products prescribed
z Score	1.018	
Significance Level	.692	
Sample Size	567	Total sites
1st Proportion	42.2	First score
2nd Proportion	12.7	Last score
z Score	11.130	
Significance Level	1.000	
Sample Size	567	Total sites
1st Proportion	45.2	Baseline: products prescribed
2nd Proportion	12.7	Last score
z Score	12.066	
Significance Level	1.000	
Number of patients studied: 3		
Combined patients Nos. 5, 7, and 12		
Sample Size	273	Total sites
1st Proportion	24.2	1st Evaluation
2nd Proportion	37.4	2nd Evaluation
z Score	3.341	
Significance Level	.999	
Sample Size	273	Total sites
1st Proportion	37.4	2nd Evaluation
2nd Proportion	7.7	3rd Evaluation
z Score	8.303	
Significance Level	1.000	
Sample Size	273	Total sites
1st Proportion	7.7	3rd Evaluation
2nd Proportion	19.8	4th Evaluation
z Score	4.105	
Significance Level	1.000	
Sample Size	273	Total sites
1st Proportion	19.8	4th Evaluation
2nd Proportion	11.0	5th Evaluation
z Score	2.848	
Significance Level	.996	

*Statistical analysis performed by Analytical Computer Services, Scottsdale, Ariz.

pensed. The mean number of bleeding sites per patient had been reduced from 23.27 to 6.55 or 71.85% ($P \leq 0.01$) (Table 1).

Three patients discontinued use of the products after the third visit. In this group, of the 101 bleeding-on-probing sites at baseline, after use of RetarDENT® toothpaste and RetarDEX® oral rinse, only 20 bleeding sites remained, with a mean decrease of 79% ($P \leq 0.01$). After discontinuing product use, bleeding on probing at the fourth recall visit showed a mean increase of 157% to 54 sites ($P \leq 0.01$). After the patients were again assigned the test products, it was noted that the bleeding sites were reduced to 31, a mean decrease of 44% ($P \leq 0.01$). The individual scores and means of these three patients are shown in Table 2. Statistical analysis of all data is shown in Tables 3 and 4.

Discussion

Bleeding can occur only with loss of the integrity and continuity between epithelial cells. In 11 patients with 239 bleeding sites, 71.85% of the sites in the patients using the 2 test products had reestablished continuity of the sulcular epithelial cells. Inasmuch as earlier investigators have shown that penetration of bacterial antigens will not occur with an intact epithelial barrier, and provided that the thiols are not present, this would suggest that these patients had returned to a more healthy state.

The regression in the group who discontinued product use suggests that for gingival health, the products should be used continuously on a daily basis.

It is interesting to speculate about the mechanisms which reduction of bleeding on probing may have occurred. Possible explanations include:

1. The reduction of volatile sulfur compounds and other thiols, such as hyaluronidase. This occurs by ClO_2 breaking the valence bonds at the sulfur atoms.
2. The possibility of elimination by oxidation of gingivain produced by *Porphyromonas gingivalis*. Gingivain is capable of breaking cell walls at the L-cysteine point and thus could have a bearing on epithelial cell integrity and cell wall continuity.
3. The activated ClO_2, which is used commercially in preparation of drinking water to elimi-

nate dead organic solutes, could play a role by reducing the cellular and food debris that bacteria use as nutrients.

4. Kaiser[6] and Orban[7,8] showed that the addition of oxygen increased the integrity of the epithelium as well as reduced the numbers of plasma cells and lymphocytes in the affected area. Chutter and Ratcliff found that the contiguous plaque from the crown into the pocket provided a wick effect for sulcular penetration. Thus, ClO_2 could neutralize thiol compounds in sulcular plaque (unpublished data, 1994).
5. A further possibility is the effect of adding oxygen to an anaerobic environment. Also, the result could be from a combination of the above or other unidentified processes.

It is questionable that the reduction in microbial component was responsible for this reduction of bleeding. Unpublished data by Armitage and by Hanson et al have shown a significant reduction of bleeding using the RetarDENT® toothpaste alone, but there was not a parallel significant reduction in the associated bacterial component.

Conclusion

This study shows that the twice daily use of ClO_2/phosphate oral-care products, RetarDEX® oral rinse and RetarDENT® toothpaste, will reduce bleeding on probing. Mechanisms of action were postulated, however, further research is needed to clarify the nature of processes involved.

Acknowledgment

Drs. Chapek, Reed, and Ratcliff are minority shareholders in Rowpar Pharmaceuticals, Inc.

References

1. Chapek CW, Reed OK, Ratcliff PA: Management of periodontitis by oral-care products. *Compend Contin Educ Dent* 15(6):740-746, 1994.
2. Muhlemann HR, Son S: Gingival sulcus bleeding—a leading symptom in initial gingivitis. *Helv Odont Acta* 15:107-113, 1971.
3. Ramfjord SP: Present status of the modified Widman flap procedure. *J Periodontol* 48:558-565, 1977.
4. Chace R: Retreatment in periodontal practice. *J Periodontol* 48:410-412, 1977.
5. Hirsch RS, Clarke NG, Townsend GC: The effect of locally released oxygen on the development of plaque and gingivitis in man. *J Clin Periodontol* 8(1):21-28, 1981.
6. Kaiser WF Jr: A clinical experiment concerned with the problem as to whether the chemical agent, urea hydrogen peroxide, influences or hastens tissue repair. *J Periodontol* 21:203-211, 1950.
7. Orban B: Atomic versus molecular oxygen. *J Periodontol* 17(4):147-152, 1946.
8. Orban B: Action of oxygen on chronically inflamed gingival tissue. *J Am Dent Assoc* 29(17):2018-2025, 1942.
9. Rizzo A: Histologic and immunologic evaluation of antigen penetration into oral tissue after topical application. *J Periodontol* 41:210-212, 1970.
10. Ng W, Tonzetich J: Effect of hydrogen sulphide and methylmercaptan on the permeability of oral mucosa. *J Dent Res* 63(7):994-997, 1974.
11. Gaffar A: Penetration of dental plaque components into gingiva: sequential topical treatments with hyaluronidase and Streptoccocal polysaccharide in rats. *J Periodontol* 52:197-205, 1981.
12. Anderson GB, Smith BA: Periodontal probing and its relation to degree of inflammation and bleeding tendency. *J West Soc Periodontol* 36(3):97-112, 1988.
13. Meitner SW, Zander H, Iker H, et al: Identification of inflamed gingival surfaces. *J Clin Periodontol* 6:93-97, 1979.
14. Caton JG, Greenstein G, Polson AM: Depth of periodontal probe penetration related to clinical and histological signs of gingival inflammation. *J Periodontol* 52:626-629, 1981.
15. van der Velden U: Location of probe tip in bleeding and non-bleeding pockets with minimal gingival inflammation. *J Clin Periodontol* 9:421-427, 1982.
16. Abbas F, Hart AAM, Oosting J, et al: Effect of training and probing force on the reproducibility of pocket depth measurements. *J Periodontol Res* 17:226-234, 1982.
17. Lang NP, Joss A, Orsanic T, et al: Bleeding on probing—a predictor for the progression of periodontal disease. *J Clin Periodontol* 13:590-596, 1986.
18. Proye M, Caton J, Polson A: Initial healing of periodontal pockets after a single episode of root planing monitored by controlled probing forces. *J Periodontol* 53:296-301, 1982.
19. Polson AM, Caton JG, Yeaple RN, et al: Histological determination of probe tip penetration into gingival sulcus of humans using an electronic pressure-sensitive probe. *J Clin Periodontol* 7:479-488, 1980.
20. Greenstein G, Caton J, Polson AM: Histologic characteristics associated with bleeding after probing and visual signs of inflammation. *J Periodontol* 52:420-425, 1981.
21. Davenport RH, Simpson DM, Hassell TM: Histometric comparison of active and inactive lesions of advanced periodontitis. *J Periodontol* 53:285-295, 1982.