Scanning Electron Microscope Evaluation of Two Methods of Resharpening Periodontal Curets: A Comparative Study

Ofer Moses,* Haim Tal,* Zvi Artzi,* Alon Sperling,† Ron Zohar,‡ and Carlos E. Nemcovsky*

Background: Effective root planing demands sharp cutting edges on dental curets. However, after several strokes, they become dull and must be resharpened frequently. The purpose of this study was to evaluate by scanning electron microscopy (SEM) the quality of the cutting edge of periodontal curets resharpened by 2 different methods.

Methods: Forty new detachable Gracey curets were used in this study. After similar blunting, all instruments were resharpened either with 10 strokes using an Arkansas fine-grit sharpening stone (AR), or with 7 strokes using a high-grit and -density aluminum oxide stone (CH). The cutting edges of each instrument were examined using SEM at 1 mm and 2 mm from the tip before and after the resharpening procedure. Bevel measurement and the amount of functional and non-functional wire edges (WE) on the cutting edge were evaluated. Data were statistically analyzed using analysis of variance (ANOVA) with repeated measures, 2-way ANOVA, and Fisher's exact test.

Results: After blunting and resharpening, differences in bevel between groups were statistically non-significant. Generally, after resharpening, there were significantly more functional and non-functional WE in the AR group than in the CH group. There were significantly more instruments with a complete absence of WE in the CH group.

Conclusions: The CH stone resulted in a smoother and better cutting edge than the AR stone. The procedure was easy to perform and required fewer strokes of the curet on the stone. *J Periodontol 2003;74:1032-1037.*

KEY WORDS

Comparison studies; dental instruments; periodontal diseases/instrumentation.

* Department of Periodontology, The Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Tel Aviv, Israel.
† Private practice, Tel Aviv, Israel.
‡ Currently, Biomaterials and Periodontal Department, Faculty of Dentistry, University of Toronto, Toronto, ON, Canada. Previously, Department of Periodontology, The Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University.

The role of bacterial plaque in the development and progression of gingivitis and periodontal disease has been well established.[1,2] Clean, smooth root surfaces should be achieved following treatment, because rough surfaces further facilitate bacterial accumulation and calculus attachment.[2-6] Therefore, high-quality cutting edges on periodontal instruments are indispensable for attaining satisfactory results.[7-11] The edge quality of a curet is determined by the angle between the 2 edge-forming contiguous surfaces,[12] by edge smoothness,[13] by edge sharpness or dullness,[14] and by the presence or absence of metallic projections (wire edges, WE).[10] An optimum cutting edge is characterized as having a smooth, contiguous meeting of the facial and lateral surfaces free of WE.[10] Wire edges can be classified as functional or non-functional. Functional WE extend in the same direction of the cutting stroke and, therefore, are capable of removing tooth structure. Curets with functional WE produce irregular root surfaces.[10] Non-functional WE are perpendicular to the cutting stroke.

Sharp curets become dull after several strokes[15] and must be frequently resharpened. Various types of resharpening stones are available. The fine abrasiveness or grit of a natural stone, such as an Arkansas stone (AR), allows a smooth surface and a linear cutting edge.[13] Synthetic stones made of aluminum oxide with large grit particles, diamond, and silicone carbide can cause unnecessary metal removal, rough surfaces, and metallic projections.[13,16] Recently, a channel-shaped stone sharpening system (CSS) for finishing periodontal curet surfaces was introduced. It includes an abrasive surface, which in a cross-sectional profile, is a negative image of the surfaced zone to be abraded or finished, and a relief surface corresponding to the zone(s) to remain unfinished. The instrument is designed with 2 channels that fit the curet shape.

The purpose of the present study was to evaluate by scanning electron microscopy (SEM) and compare the quality of the cutting edge of periodontal curets resharpened by either the CSS system or the AR sharpening stone method.

MATERIALS AND METHODS

Twenty new detachable #7 and twenty #8 Gracey curets§ were studied. After similar blunting, all instruments were resharpened with either an Arkansas fine-grit sharpening stone, (AR‖) or a high-grit and -density aluminum oxide ceramic stone (CH¶) (Fig. 1). All curets were screwed into the same handle, blunted with 6 strokes on a chromic oxide, 25-µm particle, coated metal bar# specially designed for this study. For homogenization, the length of the strokes was marked on the bar (Fig. 2). Instruments were then randomly divided into 2 groups of 10 curets each. Curets were resharpened using either the Arkansas sharpening stone (group AR) or the high-grit and -density aluminum oxide ceramic stone (group CH). The number of sharpening strokes in each group necessary to obtain the same bevel reduction was determined prior to the study. It was found that 10 strokes were necessary for the Arkansas stone and 7 for the aluminum oxide stone. In the AR group, the stone was cleaned with a gauze pad and handpiece lubricant before sharpening each instrument. The stone was fixed on a table while sliding the instrument on the surface at an angle of 100° to 110° (Fig. 3) for 10 times, operating along a 4 cm working length using a similar light force. Force intensity was not measured. In the CH group, the blunted instruments were seated on the channel-shaped stone, which presents a specifically shaped abrasive surface, and were pulled along the channels according to the manufacturer's instructions. The round side of the stone intended to reshape and smooth the facial surface of the curet was not used, since this cannot be done with the flat Arkansas stone. Each instrument was cleaned after sharpening by gently shaking in acetone for 30 seconds and allowed to dry, without any further procedure or contact with the working part of the curet.

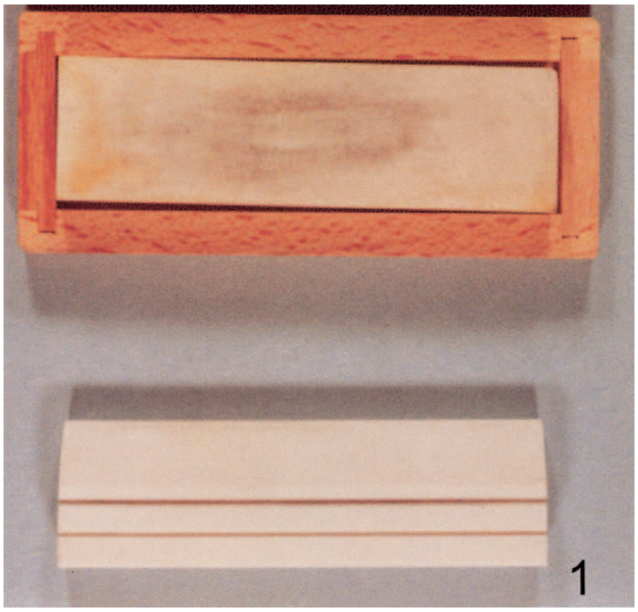

Figure 1.
Sharpening stones used in the study. ***A)*** *Arkansas stone and* ***B)*** *channel sharpening stone.*

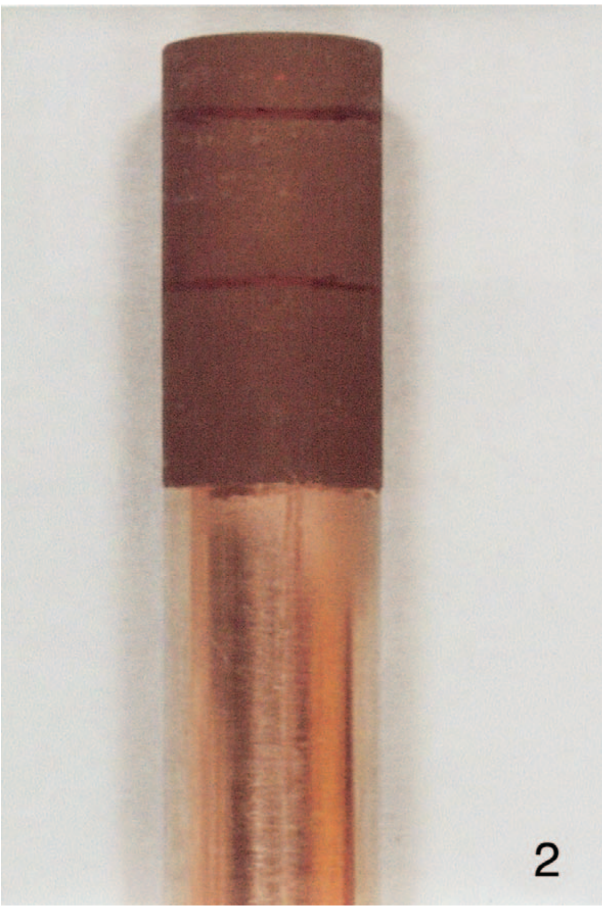

Figure 2.
Rod used to blunt the curets. The dark part of the rod was coated with chromic oxide. Instruments were blunted with 6 strokes between the 2 dark lines.

§ G. Hartzell & Son, Concord, CA.
‖ Alfred Becht GmbH, Offenburg, Germany.
¶ Honing Channel, Cutting Edge Technology LLC, Endicott, NY.
# Rockwell 70, Matas Industry, Carmiel, Israel.

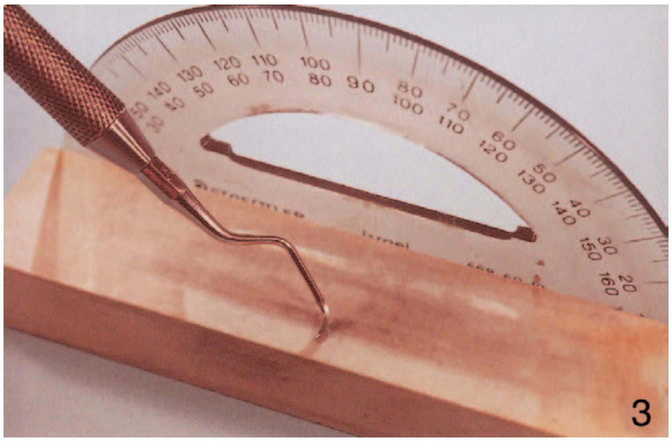

Figure 3.
Curet sharpening with the AR system. The stone was fixed on a table while sliding the instrument on the surface at an angle of 100° to 110.

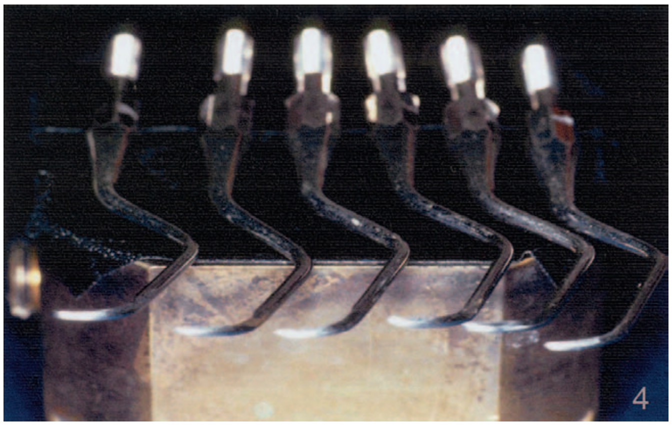

Figure 4.
Curets were fixed with adhesive tape in the same relative position to the working surface, prior to SEM examination.

Curets were fixed with adhesive tape in the same relative position to the working surface, examined under a scanning electron microscope,** (Fig. 4), and the edges photographed at 500× magnification. Pictures were taken using similar film, contrast, and brightness before blunting (new), after blunting, and after sharpening. Cutting edges were inspected at 1 mm (point A) and 2 mm (point B) from the tip of each instrument. Photographs from new and blunted curets were used to examine the homogeneity of groups and to determine the baseline bevel for both groups. Images of the instruments after sharpening were independently evaluated by 3 experienced periodontists (OM, HT, CEN). One operator (AS), who was not part of the evaluating team, performed the blunting, sharpening, and photographing procedures.

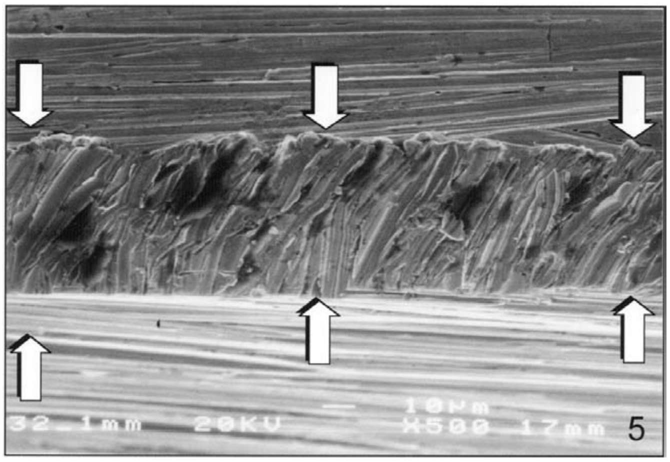

Figure 5.
Curet after blunting. Bevel is shown. The bevel for each instrument was an average of 3 points indicated by the arrows.

Evaluation parameters included bevel measurement (in µm) and functional and non-functional wire edges (WE). To avoid bias, photographs were randomly numbered with no correlation as to the type of instrument or method applied to the instrument. Evaluators received similar written evaluation forms and instructions. Functional and non-functional WE were separately rated according to a scale of 0 to 4, where 0 = complete absence of WE; 1 = presence of WE in 1% to 25% of the instrument cutting edge; 2 = 26% to 50%; 3 = 51% to 75%; and 4 = 76% to 100%. The bevel was measured at the 2 edges and the center in each photograph; measurements were averaged (Fig. 5).

Data were statistically analyzed using analysis of variance (ANOVA) with repeated measures, 2-way ANOVA, and Fisher's exact test.

RESULTS

In all statistical analyses, the independent variable was the study group (AR or CH), and the dependent variable was bevel and/or WE.

The bevel after blunting (Fig. 6) was evaluated by ANOVA with repeated measures. No significant difference ($P = 0.456$) was found in baseline bevel in both groups at points A and B and their mean. In the AR group, mean bevel was 41.5 µm (SD 6.89), while in the CH group, it was 40.5 µm (SD 5.12). However, the mean bevel at point B for both groups combined (36.090 µm ± 4.602) was significantly smaller ($P<0.001$) than the mean bevel at point A (45.920 µm ± 7.721).

Sharpening results concerning the presence of WE are presented in Figures 7 and 8. Differences in bevel size after sharpening between groups were not significant at points A or B.

** Model JSM 6300, JEOL Ltd., Akishima, Tokyo, Japan.

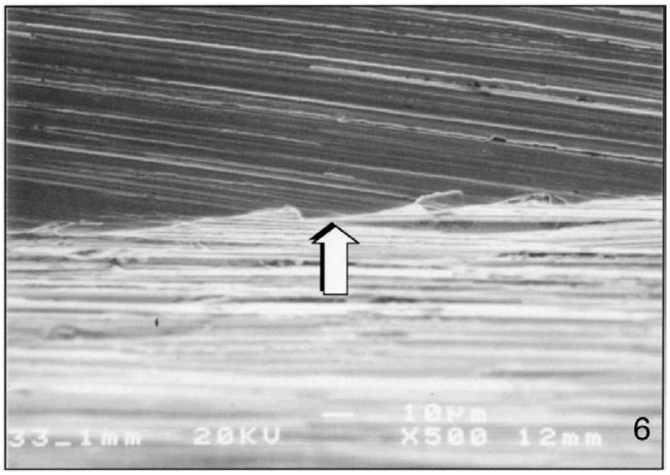

Figure 6.
Functional WE in a curet after sharpening with CSS system.

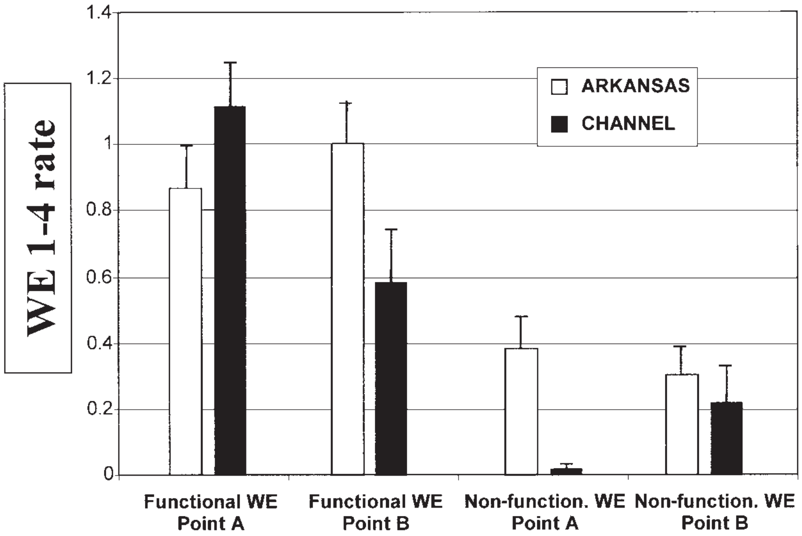

Figure 7.
WE in both groups at points A and B for all instruments.

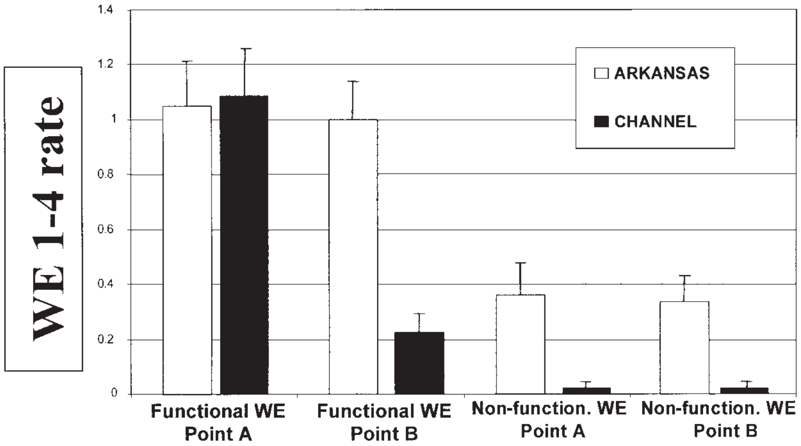

Figure 8.
WE in both groups at points A and B for instruments without bevel after resharpening.

At point A, the rate of functional WE was similar for both groups with 2-way ANOVA (Figs. 7 and 8). However, at point B, the rate was significantly smaller in the CH group ($P=0.037$): the AR group showed a mean of 1.00 (SD 0.562) and the CH group a mean of 0.583 (SD 0.708) (Fig. 7). In the AR group, 25% of all instruments presented functional WE compared to 14.6% in the CH group.

The rate of non-functional WE at point A was significantly smaller ($P=0.001$) in the CH group (0.016, SD 0.074) compared to the AR group (0.383, SD 0.436). No difference between groups was found at point B (Fig. 7). In the AR group, 9.6% of instruments presented non-functional WE, while this value was only 0.4% in the CH group.

The rate of WE among instruments showing no bevel after sharpening was analyzed by 2-way ANOVA. This group represented fully sharpened instruments; therefore, the possibility that WE may have been produced during the blunting process and not as a result of resharpening was eliminated. No difference was found between groups for the rate of functional WE at point A. However, at point B, the AR group had a mean rate of 1.00 (SD 0.594) compared to 0.22 (SD 0.272) in the CH group, which was statistically significant ($P<0.001$) (Fig. 8). Among instruments with no bevel, 25% in the AR group and 5.6% in the CH group had functional WE at point B. When the dependent variable was non-functional WE, the CH group performed better than the AR group at both points. At point A, the mean rate in the AR group was 0.36 (SD 0.44), while in the CH group, it was 0.02 (SD 0.086) (Fig. 8), which was statistically significant ($P=0.011$). Among the instruments with no bevel, 9% in the AR group and 0.6% in the CH group had non-functional WE at point A. At point B, the mean rate in the AR group was 0.33 (SD 0.412), while the mean rate in the CH group was 0.02 (SD 0.086), which was statistically significant ($P=0.011$). There were non-functional WE at point B in 8.3% of instruments with no bevel in the AR group and in 0.55% of instruments with no bevel in the CH group.

Fisher's exact test analyzed the numbers of curets with an absence of functional and non-functional WE in each group. At point A, 15% of the instruments in the CH group and 5% in the AR group exhibited a complete absence of functional WE; however, the differences were not significant ($P=0.605$). At point B, 5% of the instruments in the AR group compared to 40% in the CH group presented no WE, which was significant ($P=$ 0.02). Non-functional WE showed a similar

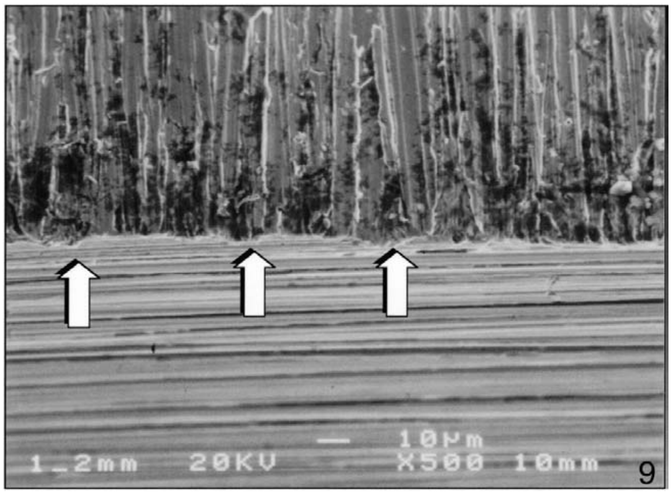

Figure 9.
Functional WE in a curet after sharpening with Arkansas stone (arrows).

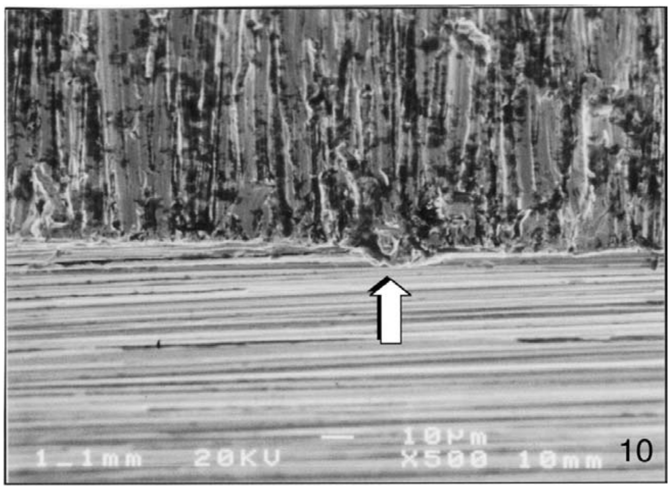

Figure 10.
Functional WE in a curet after resharpening with Arkansas stone (arrow).

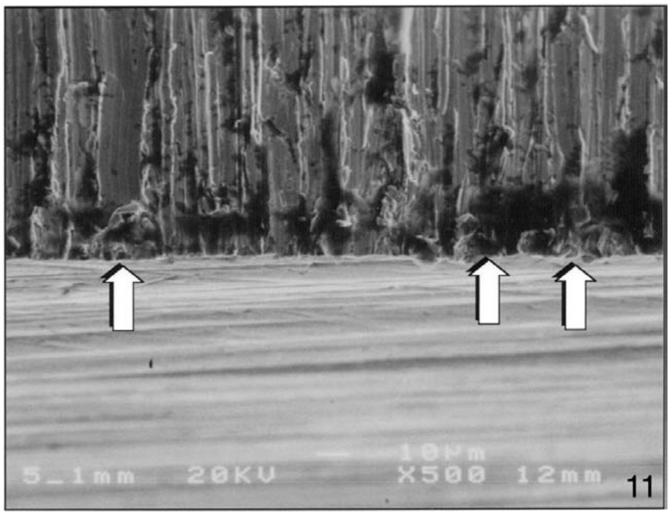

Figure 11.
Non-functional WE in a curet after resharpening with Arkansas stone (arrows).

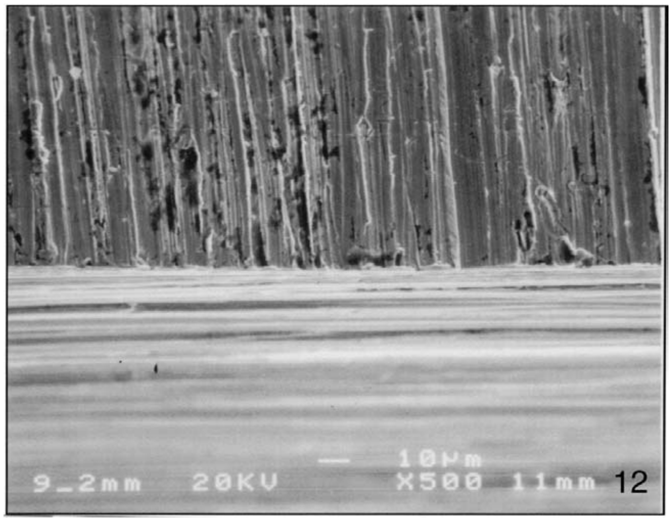

Figure 12.
Curet from the AR group after sharpening. No bevel or WE remains. Pattern of lateral surface is perpendicular to the curet face.

trend. At point A, 50% of instruments in the AR group and 95% in the CH group scored 0, which was significant ($P = 0.003$). At point B, 50% of the curets in the AR group and 80% in the CH group exhibited an absence of non-functional WE; however, the difference was not significant ($P = 0.096$).

DISCUSSION

The importance of the quality of the cutting edges on periodontal instruments is well recognized.[7,10] Sharp, smooth instruments lead to better treatment results reflected by a smooth root surface since topography of an instrumented root mirrors the cutting edge of the instrument.[17] Since sharpness is not quantifiable, only the objective components of sharpness, i.e., bevel and the presence of WE on the cutting edge of the instrument, were evaluated in this study. Evaluation was carried out by SEM analysis at 500× magnification. This method allowed differences in bevel width of even a few microns to be measured; it also allowed the presence of WE that can be seen only with high magnification to be determined.

The present study evaluated a new channel-shaped sharpening system and compared it to the widely used Arkansas flat stone. The use of the CSS resulted in a smoother and thus better cutting edge than the Arkansas stone. To accurately compare both methods, the conical side of the CH stone, which is intended to reshape and smooth the facial surface of

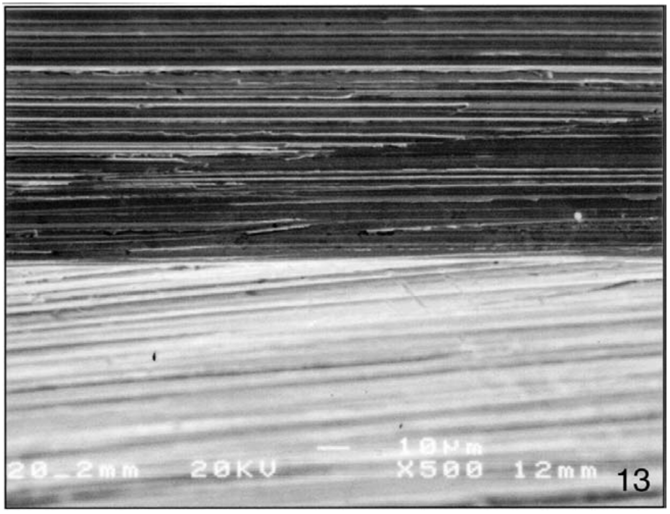

Figure 13.
Curet from the CH group after sharpening. No bevel or WE remains. Pattern of lateral surface is parallel to the curet face.

the curet, was not used since this cannot be done with the flat Arkansas stone. This finishing procedure could have eliminated even more WE, thus rendering the cutting edge with CH even smoother. Instruments were resharpened using fewer strokes in the CH group (7 strokes) than in the AR group (10 strokes), while the bevel reduction was similar in both groups. The channel-shaped system is easy and less technique sensitive than the AR stone. Since sharpening of instruments during root planing is time consuming, a faster and easier method is preferred. The instrument strokes on the CH stone are parallel to the cutting edge, and the instrument is in close contact with the channel walls; therefore, the possibility of WE formation is largely reduced. Sharpening strokes on the AR stone are done perpendicularly. A different pattern on the resharpened edge was shown with each method (Figs. 9 through 13).

It should be mentioned that in 30% of instruments at point A and in 17.5% at point B, some bevel remained after resharpening. Therefore, to obtain 100% bevel reduction in all instruments, more strokes should have been used. However, in clinical practice, extensive instrument resharpening causes rapid wear.

This study was an in vitro determination of the quality of the cutting edge on periodontal curets that were resharpened using 2 systems. However, other studies are necessary to investigate the clinical relevance of these findings.

ACKNOWLEDGMENTS

The authors wish to thank G. Hartzell & Son for supplying the curets; Cutting Edge Technology LLC for supplying the Honing Channel sharpening stones; Nissim Cohen from Matas Industry, Dr. Zehava Barkai, and Dr. Avi Olos for their help with the scanning electron microscopy; Mr. Rellu Samuel for photography; and Ms. Rita Lazar for editorial assistance.

REFERENCES

1. Theilade E, Theilade J. Role of plaque in the etiology of periodontal disease and caries. *Oral Sci Rev* 1976; 9:23-3.
2. Löe H, Theilade E, Jensen SB. Experimental gingivitis in man. *J Periodontol* 1965;36:177-187.
3. Daly CG, Seymour GJ, Keiser JB, Corbet EF. Histological assessment of periodontally involved cementum. *J Clin Periodontol* 1982;9:266-274.
4. O'Leary TJ, Kafrawy AH. Total cementum removal: A realistic objective? *J Periodontol* 1983;54:221-226.
5. Adriens PA, Debover JA, Loesche WJ. Bacterial invasion in root cementum and radicular dentin of periodontally diseased teeth in humans. A reservoir of periodontopathic bacteria. *J Periodontol* 1988;59: 222-230.
6. Zander HA. The attachment of calculus to root surface. *J Periodontol* 1953;24:16-19.
7. Paquette OE, Levine MP. The sharpening of scaling instruments: An examination of principles. *J Periodontol* 1977;48:163-168.
8. Green E, Ramfjord S. Tooth roughness after subgingival root planing. *J Periodontol* 1966;37:396–399.
9. Wilkinson RF, Maybury JE. Scanning electron microscopy of the root surface following instrumentation. *J Periodontol* 1973;44:559-563.
10. Antonini CJ, Brady J, Levine MP, Garcia WL. Scanning electron microscope study of scalers. *J Periodontol* 1977; 48:45-48.
11. Biller IR, Karlsson UL. SEM of curet edges. *Dent Hyg (Chic)* 1979;53:549-554.
12. Allen D, McFall WT, Hunter GC. *Periodontics for the Dental Hygienist,* 2nd ed. Philadelphia: Lea & Febiger; 1974:117.
13. Wilkins EM. *Clinical Practice of the Dental Hygienist,* 3rd ed. Philadelphia: Lea & Febiger; 1971:186.
14. Glickman I. *Clinical Periodontology: Prevention, Diagnosis and Treatment of Periodontal Disease in the Practice of General Dentistry,* 4th ed. Philadelphia: W.B. Saunders Co.; 1972:612-615.
15. Tal H, Kozlovsky A, Green E, Gabay M. Scanning electron microscope of wear of stainless steel and high carbon steel curettes. *J Periodontol* 1989;60:320-324.
16. Steele PF. *Dimension of Dental Hygiene.* Philadelphia: Lea & Febiger; 1966:211.
17. Rossi R, Smukler H. A scanning electron microscope study comparing the effectiveness of different types of sharpening stones and curets. *J Periodontol* 1995;66:956-961.

Correspondence: Dr. Carlos E. Nemcovsky, Department of Periodontology, School of Dental Medicine, Tel Aviv University, Tel Aviv, Israel. Fax: 972-3-6409250; e-mail: carlos@post.tau.ac.il.

Accepted for publication January 21, 2003.