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Evaluation of three different manual techniques of sharpening curettes through a scanning electron microscope: a randomized controlled experimental study

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Abstract: *Objective:* The purpose of this study was to compare the effectiveness of three different techniques for manually sharpening of periodontal curettes (PCs) by examining the blades with the aid of scanning electron microscope (SEM). *Methods:* Three groups were considered based on three sharpening methods used: group A (moving a PC over a stationary stone); group B (moving a stone over a stationary PC) and group C (moving a PC over a stone fixed, placed on a 'sharpening horse'). After the sharpening, the blades were examined using SEM. The SEM images were assessed independently by five different independent observers. An evaluation board was used to assign a value to each image. A preliminary pilot study was conducted to establish the number of samples. Pearson's correlation test was used to assess the correlations between measurements. ANOVA test with Bonferroni's post hoc test was used to compare the three groups. *Results:* Sixty PCs (20 PCs per group) were used in this study. Statistically significant differences emerged between the three groups (P-value = 0.001). Bonferroni's test showed that the difference between groups A and B was not statistically significant (P-value = 0.80), while it was significant for the comparisons between groups A and C (P-value = 0.005) and between groups B and C (P-value = 0.001). *Conclusions:* The sharpening technique used in group C, which involved the use of the sharpening horse, proved the most effective.

Key words: dental instruments; sharpening; stones; subgingival curettage

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Introduction

Periodontal disease is an infectious inflammatory disease process that affects the periodontium (1). Many causes can contribute to the manifestation and progression of this disease, one of which is bacterial plaque (2, 3) that through direct and indirect mechanisms causes the destruction of the periodontium (4, 5) with a progressive reduction of the biocompatibility between the periodontal tissues and the surface of the dental root (4, 6, 7). A well-performed non-surgical periodontal therapy reduces the degree of inflammation and periodontal oedema and make the root surfaces smoother (8, 9) and more compatible with the surrounding tissues (10, 11). The tools most commonly used in non-surgical periodontal therapy are periodontal curettes (PCs). (12) For the optimal use, the blade of a PC must be perfectly smooth and sharp (13–15) to leave the surface of the treated root smooth and clean. Root surface roughness facilitates the adhesion of bacterial (16, 17) and the consequent development of a bacterial biofilm. The success of non-surgical periodontal treatment partially depends on the quality of the blade on the PC (18, 19). The blade is determined by the angle originating from the point where its lateral and coronal surfaces meet (20), while the blade's quality depends on how even (21) and sharp it is, and on the presence or absence of wire edges (22). A sharp tool enables better results to be achieved and affords several advantages (10, 23), including a greater accuracy and efficacy, and a lower risk of causing burnished calculus or soft tissue trauma or undermining the tooth. The literature shows that the stone most commonly used in sharpening procedures is the Arkansas stone, because it is composed of particular microparticles that produce the best results on the blade (24–29). Coarse grinding stones instead produce 'wire edges' (4, 25, 26, 29–32), which could affect the final outcome of therapy (4, 22, 25, 33, 34), and potentially damaging the root surface. A new instrument called a 'sharpening horse'(SH) (DH Methods, Tallahassee, FL, USA) has recently been proposed to facilitate the sharpening of PCs. The SH is a sharpening system in which the stone remains stationary and the PC is moved; it uses a 'fulcrum-controlled sharpening technique' that is suitable for both right- and left-handed practitioners. SH is easy to use; all the operator must do is slide the instrument against the stone while maintaining the same angle between the blade and the stone. To be more precise, the operator places the heel of the far left-hand side of the stone then slides the PC to the right while turning its blade from the heel third to the middle third, and from there to the toe third and tip in order to maintain its original shape. The aim of this study was to compare three manual curette sharpening techniques with the aid of a scanning electron microscopy (SEM). The techniques involved: moving a PC over a stationary sharpening stone; moving a sharpening stone over a stationary PC; and moving a PC over a stationary stone placed on a sharpening horse (SH).

Materials and methods

A sample of 60 new standard 5/6 stainless steel PCs with an octagonal handle (Hu-Friedy, Chicago, IL, USA) was

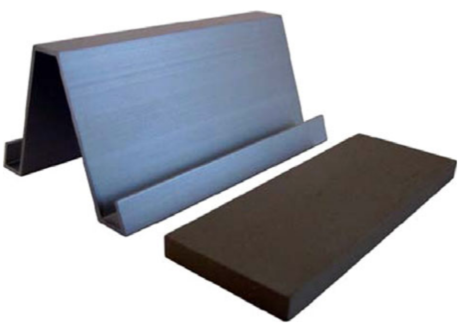

Fig. 1. The sharpening horse.

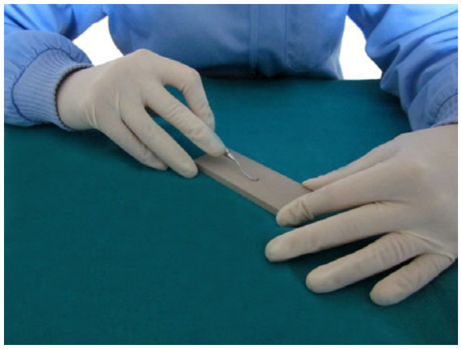

Fig. 2. Moving a PC over a stationary sharpening stone (group A).

examined. A fine-grained Arkansas stone (Hu-Friedy) was used to sharpen the PCs. The PCs were divided into three groups of 20 PCs each using a computer-based randomization process, and each group of PCs was colour-coded with rings. In group A (yellow ring), the tools were sharpened by moving the PCs over the stationary sharpening stone; in group B (red ring), the sharpening stone was moved over a stationary PC; in group C (green ring), the stone was held stationary in the SH (DH Methods) and a PC was moved over it. The SH consists of a sheet metal profile shaped so as to house the stone at an angle suitable for sharpening purposes (Fig. 1). For group A, the stone was placed on the work bench and the angle between the PC blade and the stone had to be 40°. The operator had to swing the instrument from heel to toe until the blade was sharp (Fig. 2). For group B, the operator held the stone in his/her dominant hand and the PC in the other, and slid the stone against the blade while retaining an angle of 110° between the two. The operator had to adapt the stone to the blade, moving again from heel to toe repeatedly until the blade was sharp (Fig. 3). For group C, the PC was placed against the stone with its face parallel to the work bench. The operator had to glide along the stone while pressing the lateral border of the PC blade against it, movving from the heel third to the middle third, and then to the toe third, rolling the instrument to turn it so as to retain the shape of the toe (Fig. 4). For each of the 20 PCs in each of the three groups, a second coloured ring was used to identify each instrument. Before they were sharpened, all PCs were analysed under the scanning electron

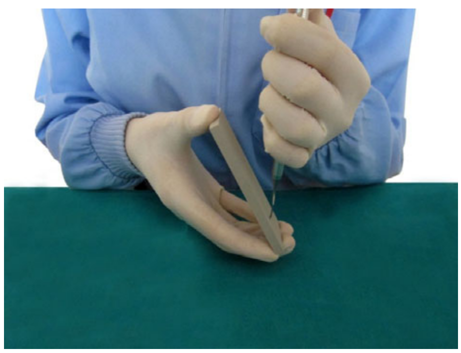

Fig. 3. Moving a sharpening stone over a stationary PC (Group B).

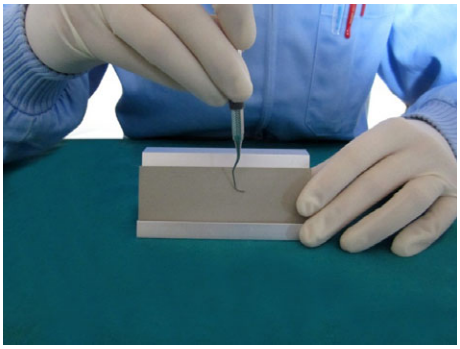

Fig. 4. Moving a PC over a sharpening stone placed on the sharpening horse (Group C).

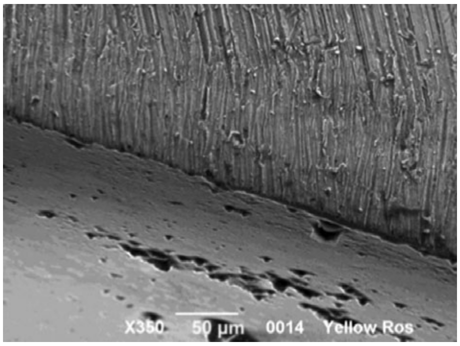

Fig. 5. 350× magnification: moving a PC over a stationary stone.

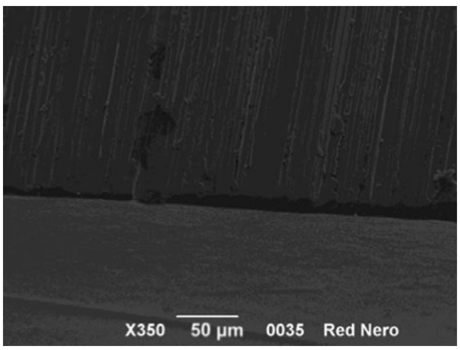

Fig. 6. 350× magnification moving a sharpening stone over a stationary PC.

microscope (SEM) (model Jeol JSM 6490) and baseline measures were comparable. The 60 PCs all had the same characteristics before the three different techniques of sharpening. Frames were obtained for each PC at 350× magnification (Figs 5–7). After sharpening 15 curettes to calibrate the method, a dental hygienist skilled in all three different methods sharpened all the PCs, testing their sharpness with a plastic stick. To do so, the operator placed each blade against the stick and checked whether it remained hanging from the stick (if the blade was sharp) or not (if the blade was not sharp). The plastic stick however was not sufficient as a test because the precision of the testing procedure depends only on the

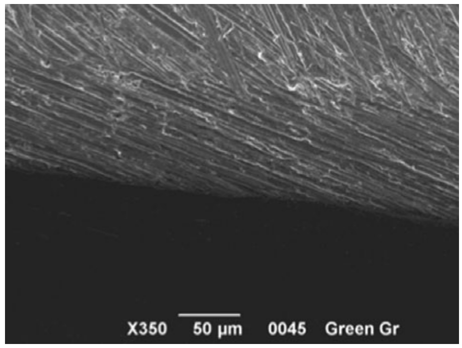

Fig. 7. 350× magnification: moving a PC over a stone placed in the sharpening horse.

operator. The SEM instead can give a clear image of the blade that can be easily evaluated and compared in a precise way. The SEM testing method can give more reproducible results. Subsequently, the wear on the PC was examined by SEM. In examining the frames, three fundamental parameters (FP) were considered: regularity of the cutting angle, the presence or absence of the bevel and the presence or absence of wire edges. The frames obtained through the use of SEM were independently scored by 5 observers blinded to the sharpening method used for each PC, who classified the results according to an index designed to take the FP into account. The five observers were all experienced dentists with experience of research in which samples were analysed using SEM. As there was now holly objective way to establish the sharpness degree of the curettes, Pearson's test method was used to assess it statistically by scoring the SEM images analysed as follows:

Score 1: sharp cutting angle and lateral surfaces without wire edges;

Score 2: cutting angle slightly irregular with or without wire edges;

Score 3: cutting angle markedly uneven, with or without wire edges;

Score 4: cutting angle not defined, with the presence of bevel and a third surface. The score and the analysis considered four points (1, 2, 3 and 4).

Statistical analysis

The PC was considered as the statistical unit. The primary variable was the percentage of the total sharpening score for a given PC based on the SEM images. A pilot study was conducted to generate data on the expected effect size and standard deviation (SD) to enable statistical power calculations. The number of sample provided for the calculation was 60 PCs, 20 for each group. The level of statistical significance was set at $\alpha = 0.05$ for a statistical power of 80%. The mean score obtained for group A was 2.5 (SD 0.55), for group B it was 2.5 (SD 1.22) and for group C it was 2 (SD 0.63). The null hypothesis for differences between the means was set to a value of 0.5. Twenty PCs per group were then estimated after power calculation. The sample size was set to 60 PCs. Pearson's correlation analysis was used to

Table 1. Descriptive statistical analysis of the scores obtained in the measurements

	Observer 1		Observer 2		Observer 3		Observer 4		Observer 5	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Group A	2.3	0.44	2.5	0.97	2.5	0.51	2.2	0.70	2.5	0.51
Group B	2.9	0.97	3.1	0.60	3.4	0.81	3.4	0.68	3.2	0.94
Group C	1.5	0.51	1.6	0.51	1.6	0.60	1.6	0.50	1.6	0.51

identify any correlation between the measurements. The Kappa test was performed to assess whether there was a correlation between the operators. One-way analysis of variance (ANOVA Test) with a post hoc analysis using Bonferroni's test was used to compare the three groups. The level of statistical significance was set as $\alpha = 0.05$ and statistical power of 80%. All testing were performed by the use of SPSS 16.0 software package (SPSS inc, Chicago, IL, USA). Statistical analysis was performed using statistical software SPSS 16.0 (SPSS Inc.).

Results

From the Pearson's correlation test was obtained $r = 0.9$, this means that there is a positive correlation between the scores returned by the five observers. A descriptive statistical analysis of the scores of the measurements awarded by the five observers is shown in Table 1. The Kappa test resulted in a value of 0.88, indicating a good consistency between the observers. The mean score for group A was 2.4 (0.62), that is on average, the PC blades in this group had a slightly uneven cutting angle with or without wire edges. The mean score for group B was 3.2 (0.80), indicating a markedly uneven cutting angle on the blade, with or without wire edges. For group C, the mean score was 1.58 (0.53), meaning that the observers judged the PC blades to have a sharp cutting angle and lateral surfaces without any wire edges.

The results of the descriptive statistical analysis on the frequencies of the scores obtained for the three groups are shown in Table 2. ANOVA generated a P-value ($P = 0.001$), identifying statistically significant differences between the three groups. Bonferroni's post hoc tests indicated, however, that the difference was not statistically significant between the group A and B (P-value = 0.80), whereas it was statistically significant when the comparison was drawn between the group C and group A (P-value = 0.005) and between the group C and B (P-value = 0.001). The statistical analysis thus demonstrated that the technique involving the use of the SH to support the stone (group C) archived significantly different sharpening results from those obtained with the other two techniques, that is the observers awarded lower scores for the PC blades in group C than for those in groups A or B.

Table 2. **Descriptive statistical analysis of the frequencies of the scores obtained in the three groups**

	Score 1 (%)	Score 2 (%)	Score 3 (%)	Score 4 (%)	
Group A	3	56	41	0	100
Group B	6	20	27	47	100
Group C	45	53	2	0	100
	54 (18%)	129 (43%)	70 (23.3%)	47 (15.7%)	300

Discussion

Scaling and root planning are a critical step in the treatment of periodontal disease (35). In the same way that is necessary to know the techniques of periodontal therapy, it is essential to know how to preserve and restore the efficiency of the tools once they prove worn. Several authors, such as Acevedo 2002 (24) and Rossi 1995 (26) have shown that the morphological characteristics of the blade are transferred directly to the root surface being treated. A poorly sharpened tool gives rise to a greater contact area between the lateral surface of the blade and the root, obliging the operator to apply more force and pressure during the treatment. Hence, the need to re-establish the cutting angle on the blade and sharpen it properly is important to perform a correct non-surgical periodontal therapy. Curette sharpening relies on manual techniques and the operator's expertise. A recent study by Acevedo, Sampaio and Shibli (4) showed that, for manual sharpening purposes, the fine-grained Arkansas type of stone provides the best results because these sharpening stones have small abrasive particles and they can be used to obtain sharp, smooth and precise edges. The coarser grinding stones instead have a greater abrasive capacity and produce less even cutting corners. For this reason, in the present study was used a fine-grained Arkansas stone.

Were examined three techniques of manual sharpening: group A (moving a PC over a stationary stone), group B (moving a stone over a stationary PC) and group C (moving a PC over a stationary stone supported on a sharpening horse). The first two techniques (group A and group B) are commonly used in clinical practice, in particular the method with the stone moving and the PC held still appearing to be the most widespread (4). Judging from our results using a sharpening horse as in our group C produced significantly better results in term of a more accurate sharpening action than the methods used in group A and B. In fact, moving the PC over the stone (as in group A) ensures a firm support and maintains a constant sharpening angle, but cannot guarantee a good view of that corner; moving the stone over the PC (group B) gives the operator a better view but makes it difficult to maintain the sharpening angle because the stone lacks stability and the PC is impossible to keep perfectly immobile because the operator is bound to make some involuntary movements, however minimal (36). It is worth adding that the technique used in group A reduces the risk of accidents, as the works is carried out on a stable surface (37). The holder or horse used in group C proved capable of overcoming the disadvantages of the techniques used in groups A and B, without any loss of their respective advantages. Judging from the results of Kappa's test, there was a good inter-rater consistency among the five operators who examined the SEM frames. The tests conducted with the plastic sticks after using the three sharpening techniques indicated a good sharpness of the blades in all three groups, but the method was unable to establish whether one technique was better than another. SEM, on the other hand, was able to discriminate between the sharpening methods considered, giving a clear image of the blade that was easy to assess and compare precisely. The SEM-based testing method can also give more reproducible results than the test with the plastic sticks (26). The quality of a curette depends on the sharpness of the angle originating from its coronal and lateral surfaces. In our groups A and B, some blades revealed an irregular profile with a third surface or bevel and jagged burs (the so called wire edges). These irregularities may be 'functional' or 'non-functional'. The former are generated by the sharpening of the lateral surfaces and lie parallel to the pulling movement carried out during the root scaling action. Although they can foster the fracture of the calcified deposits on a dental root, they do not contribute to smoothing its surface; such irregularities do not damage the root surface, however, and that is why they are termed 'functional'. The latter, non-functional irregularities lie perpendicular to the movements performed during root scaling procedures and originate from the sharpening of the coronal surface (4). The resulting serrated surface of the blade is more troublesome than the above-described functional irregularities because it can scratch the root's surface. Using the technique involving a holder, or horse, to support the stone (group C), on the other hand, the cutting edge where the lateral and coronal surfaces meet was, in the majority of cases, precise and clean, with no third surfaces or jagged edges. Our SEM analysis showed that the technique that involved moving the PC blade over a stone held stationary on the sharpening horse (group C) produced the best results. The scores obtained for the other two groups (A and B) were much the same, a finding apparently inconsistent with Acevedo's publication in 2007 in the Journal of Contemporary Dental Practice (4). The findings of the present study are in agreement with the report from Acevedo (4); however, in the sense that both studies confirmed that the two conventional sharpening techniques are effective. Finally, it is worth adding that, although only PCs were used in the present study, the sharpening can be used to sharpen other dental instruments too, presumably achieving the same improved results.

Conclusions

With the limitations of this *in vitro* study it is observed that Group C (supported fixed stone and moving PC) is the technique that has produced the best results. Based on the results obtained, we can state that the use of the media is a real advantage in the techniques of manual sharpening, but new studies performed clinically must be conducted to confirm the results.

Clinical relevance

Many studies have been made about sharpening periodontal curettes (PC). Most of them analyse the effect of different sharpening stones on the blade or the wear of the instrument after scaling. Instead, in this study the authors compared the manual sharpening techniques (sharpening stone fixed and moving PC; sharpening stone in motion and stationary PC and sharpening stone fixed, sharpening through the sharpening horse and PC in motion). To obtain a good oral hygiene is necessary the use of PC sharpened correctly, the authors conclude that the best way of sharpening the PC is achieved through the sharpening horse.

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