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A Scanning Electron Microscope Study Comparing Between Manual and Power-Driven Sharpening Tools for Periodontal Scalers.

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ABSTRACT

Periodontal instruments should have high quality cutting edges for optimal periodontal debridement. The current study compares the efficiencies of manual and power-driven sharpening tools. 24 double ended periodontal scalers were randomly divided into 6 groups, each consisting of four scalers with eight working edges. In group I (the control group), the cutting edges were not sharpened. Group II included four dull instruments that were not resharpened, while the rest were resharpened either manually with Arkansas (group III),India (group IV), or using power driven sharpeners as SideKick (group V), or InstRenew, (group VI). The scalers of all groups were separated from their stems and a scanning electron microscopy was used to examine the quality of the cutting edges. The lowest mean score was in group III , while the highest was in group IV, with a mean and standard deviation values of 1.4 ± 0.5, and 3.4 ± 0.7 respectively. Groups I, II, IV and V showed a mean and standard deviation values of 1.3± 0.5, 3.6 ± 0.5 ±1.9 ±0.8 and 3.0 ±0.8 respectively. The manual sharpening tools were superior to power-driven sharpeners in this study, with best results seen in the finer manual stones.

Keywords: sharpening, periodontal, scalers, scanning electron microscopy.

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INTRODUCTION

Bacterial plaque and calculus are the prime etiologic factors for initiation and progression of gingivitis and periodontal diseases. The aim of periodontal treatment is therefore directed towards removal of these deposits and arresting disease progression. Because surface irregularities are known to facilitate bacterial colonization and calculus attachment, periodontal instruments should have sharp high quality cutting edges in order to obtain a clean and smooth root surfaces after debridement [1,2]. The emphasis on the importance of high quality cutting edges of periodontal instruments has been regarded to be of great significance [3]. Several factors determine the quality of the instruments' edges such as the angle between the two edge-forming contiguous surfaces, edge sharpness or dullness, edge smoothness and the presence of unsupported metallic extensions from one of the surfaces forming the cutting edge, the so called wire edges [WE] [4,5]. There are two types of WE, functional WE that do not damage the root surface as they extend in the same direction as the cutting stroke; and non-functional WE, which are perpendicular to the cutting stroke and can thus scratch the root surface. The meeting of the facial and lateral surfaces of an ideal cutting edge should be smooth and contiguous and the edge should be free of WE [6].

Periodontal scalers quickly lose their sharp edges and thus should be resharpened to maintain their efficiency. That are several types of resharpening techniques , manual and power driven. Manual resharpening stones are either natural e.g. Arkansas stone, India or synthetic made of aluminium oxide , diamond and silicone carbide [7]. Power driven sharpeners like Hu Friedy Side Kicks® and Nordent InstRenew® have been introduced to facilitate the sharpening of scalers and curettes and produce faster and precise sharpening . The Sidekick® sharpener can control blade angulation by providing an instrument guide channels and a vertical backstop , which help putting the scalers/curettes in the correct position and provide reliable sharpening results . In InstRenew, the blade positioner locks the instrument into the correct position, while the tip clamp allows an easy grasp of any straight portion of the instrument's shank.

The purpose of the present study was to evaluate and compare the quality of cutting edges of periodontal scalers sharpened by power or manual driven sharpeners using a scanning electron microscope [SEM].

MATERIALS AND METHODS

Twenty four new double-ended hygienist scalers [Healthco ®, Tualatin, USA] H6/7 were randomly selected and divided in six groups, each group consisting of four scalers with eight working edges [table 1].The random allocation sequence was generated using an online randomizer [http://www.randomization.com] by H.N. Furthermore, the allocation concealment was achieved by sequentially opaque numbered containers. Both operators were blinded after the assignment of the scalers to the various groups.

Table 1. Characteristics of the six studied groups

Group I	Factory Sharpening, control group
Group II	Instruments dulled, no resharpening
Group III	Manual Sharpening using Arkansas Stone
Group IV	Manual Sharpening using India Stone
Group V	Power -driven Sharpening using Side Kicks®
Group VI	Power- drive Sharpening using InstRenew®

The scalers were assigned to the various groups by S.N. as follows: Four scalers were randomly assigned to the control group [group I], where cutting edges were not sharpened. The remaining twenty scalers with forty working edges were dulled using a rod containing aluminum oxide [200 µm], which was marked to ensure a consistent dulling stroke length. Each cutting was dulled by scaling for 5 strokes to ensure consistency. Group II included four dull instruments that were not resharpened, while the rest of the dulled instruments were resharpened either manually with Arkansas [Hu Friedy®, Illinois, USA] [group III], India [Hu Friedy®, Illinois, USA] [group IV], or using a power driven sharpeners as SideKick [Hu Friedy, Illinois, USA] [group V], or InstRenew [Nordent, Illinois, USA], [group VI].

All manual resharpening of the instruments was performed by the same operator H.N. following the technique prescribed by Acevedo et al. 2006 [8]. While fixing the stone on a table, gentle force was used to slide the instrument on the surface of the stone at a 100°-110° angle, operating along a 4 cm working length. The power driven sharpeners were used following the manufacturer's instructions.

At the end of sharpening, sharpness was confirmed using plastic test sticks and each instrument was then gently shaken in acetone for 30 seconds to clean it and then left it to dry, without any further procedure or contact with the working part of the scaler. The scalers of all six groups were then separated from their stems and a SEM [Jeol JXA- 840A, JEOL, Ltd®, Tokyo, Japan] was used to examine the quality of the cutting edges. All photomicrographs of the experimental areas were evaluated by a single examiner S.N.and scores were given according to the 'Cutting Edge Index' developed by Acevedo et al. [8] as follows:

Score 1: A precise angle of the coronal and lateral faces without wire edges.
Score 2: A slightly irregular cutting angle with or without wire edges.
Score 3: A markedly irregular cutting angle with or without wire edges.
Score 4: An undefined cutting angle with presence of a bevel or a third surface.

Statistical analysis

Sample size calculation

The level of statistical significance was set at a = 0.05 for a statistical power of 80%. The null hypothesis for differences between the means was set to a value of 1. 8 scalers per group were then estimated after power calculation.

Data of the scores are represented by mean, standard deviation [SD], median, range and 95% Confidence Interval [95% CI] values [table 2, Fig.7]. Data showed a non-parametric distribution, so Kruskal-Wallis test was used to compare between the different groups. Mann-Whitney U test with Bonferroni's adjustment was used for pair-wise comparisons between the groups. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM®SPSS® Statistics Version 20 for Windows [IBM Corporation, NY, USA].

RESULTS

Descriptive statistics for scores of the different groups are presented in Table [2]. The lowest mean score was in group III with a mean and standard deviation values of 1.4 ± 0.5, while the highest scores were in group VI with a mean and standard deviation values of 3.4 ± 0.7. Groups I, II, IV and V showed a mean and standard deviation values of 1.3± 0.5, 3.6 ± 0.5 ±1.9 ±0.8 and 3.0 ±0.8 respectively. When groups II, V and VI were compared using the Pair-wise comparison test, no significant difference was found between those groups, between; all showed the statistically significantly highest mean scores. Similarly no significant difference was found between Group I, Group III and Group IV; all demonstrating the statistically significantly lowest mean scores.

Table 2. Descriptive statistics and results of Kruskal-Wallis and Mann-Whitney U tests for the comparison between scores of the six groups

Group	Mean	SD	Median	Minimum	Maximum	95% CI		P-value
						Lower bound	Upper bound	
Group I	1.3^{B}	0.5	1.0	1.0	2.0	0.86	1.64	<0.001*
Group II	3.6^{A}	0.5	4.0	3.0	4.0	3.19	4.06	
Group III	1.4^{B}	0.5	1.0	1.0	2.0	0.94	1.81	
Group IV	1.9^{B}	0.8	2.0	1.0	3.0	1.18	2.57	
Group V	3.0^{A}	0.8	3.0	2.0	4.0	2.37	3.63	
Group VI	3.4^{A}	0.7	3.5	2.0	4.0	2.75	4.00	

*: Significant at $P \leq 0.05$, Different superscripts in the same column are statistically significantly different

Evaluation of SEM photomicrographs of the studied groups showed the following:

Group I: Factory sharpening showed some defects and functional wire edges. No exact junction between the coronal and lateral faces [bevel] was found, and there were no defects in the cutting angle of the manufacturer sharpened scaler [Fig. 1].
Group II: Dulling of the instruments showed bevels, some irregularities and some defects [Fig. 2].
Group III: The sharpening technique used in this group produced a precise and clear angle between the faces, creating a defined cutting angle without wire edges [Fig. 3].
Group IV: The technique used in this group produced a slightly irregular cutting angle with some functional wire edges [Fig. 4].
Group V: The technique used in this group presented an ill-defined cutting angle and bevel formation between the faces [Fig. 5].
Group VI: The technique used in this group produced an irregular cutting angle with some functional wire edges [Fig. 6]

Figure 1: Factory sharpening showing some defects and functional wire edges. No exact junction is noticed between coronal and lateral faces, and no defects are seen in the cutting angle of the manufacturer sharpened scaler (SEM: 250X and 500X).

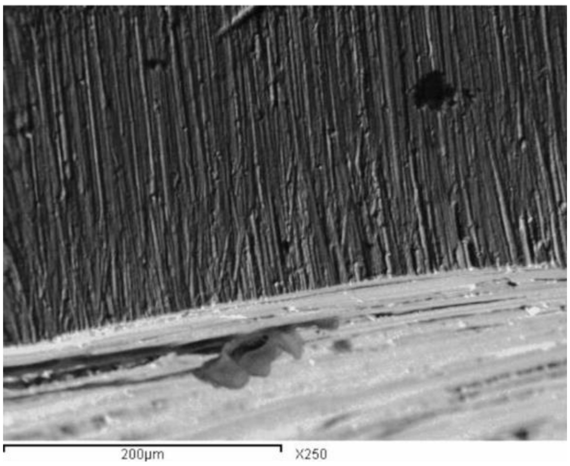


Figure 2: Dulling of the instruments showing bevels, some irregularities and some defects (SEM: 250X and 500X).

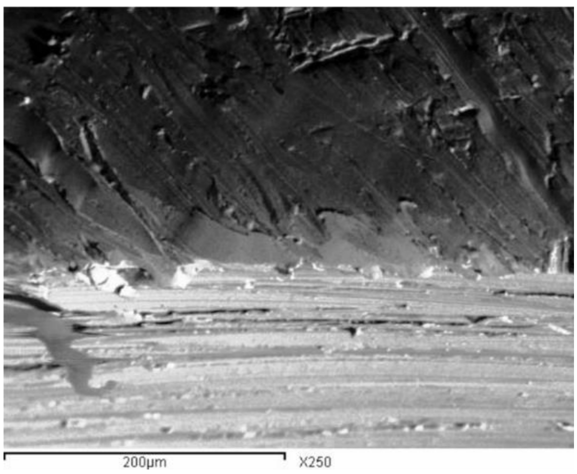


Figure 3: Sharpening using Arkansas stone demonstrating a precise and clear angle between the faces, with a defined cutting angle and no wire edges (SEM: 250X and 500X).

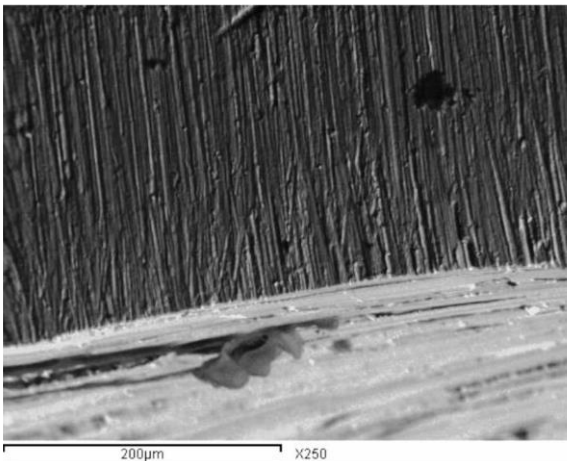


Figure 4: Sharpening using India stone showing a slightly irregular cutting angle with some functional wire edges (SEM: 250X and 500X).

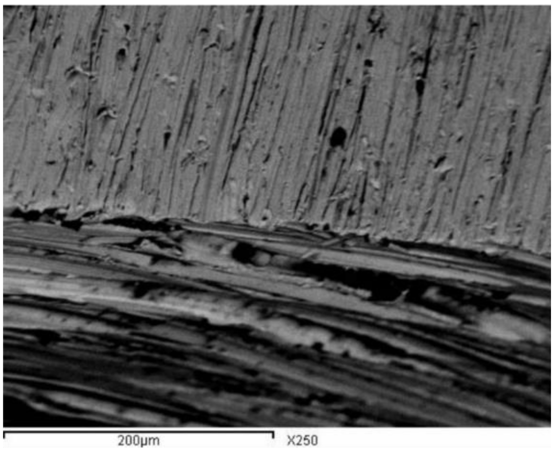


Figure 5: SideKick power-driven sharpening illustrating an ill-defined cutting angle and bevel formation between the faces (SEM: 250X and 500X).

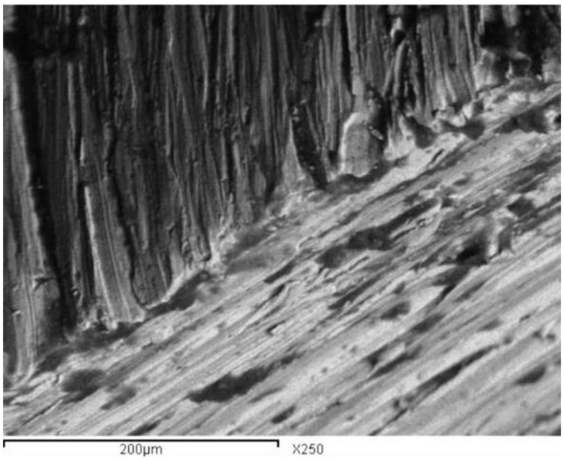


Figure 6: InstRenew power-driven sharpening demonstrating an irregular cutting angle with some functional wire edges (SEM: 250X and 500X).

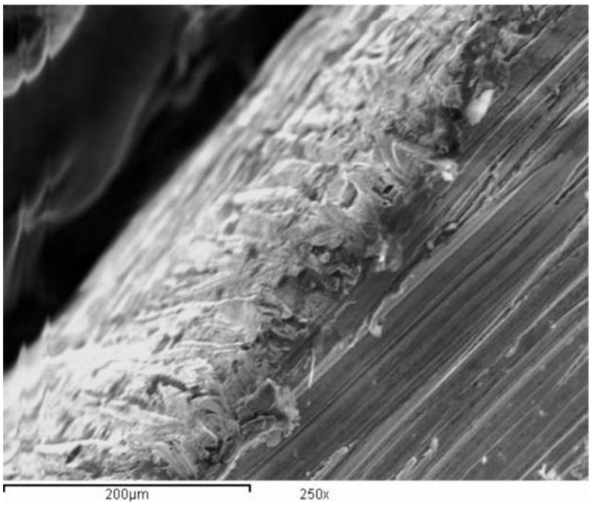
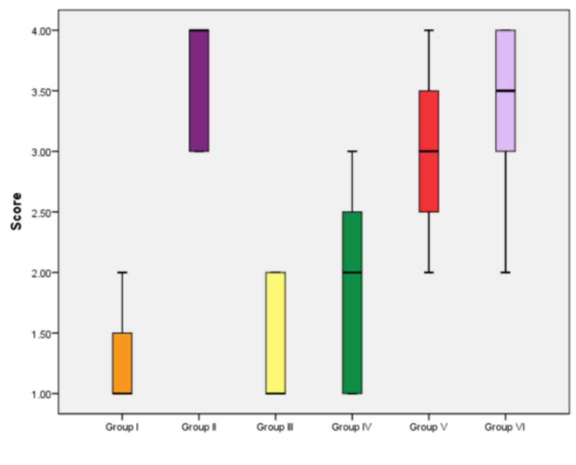


Figure 7: Box plot representing scores of the different groups (The circle represents an outlier).



DISCUSSION

Several studies have highlighted the importance of the quality of the cutting edges of periodontal instruments in obtaining smooth root surface. [6,9, 10] . Periodontal instruments tend to dull quickly after frequent use and may result inefficient scaling and root planning, fatigue of the clinician or accidental instrument's slipping and soft tissue damage. Resharpening of these instruments is therefore advised to regain their efficiency and ensure the maintenance of high quality cutting edges. [11,12]. A sharp tool will leave the root surface smooth and clean, offer the clinician greater accuracy and efficiency during work as well as lower the risk of causing burnished calculus or soft tissue trauma [5]

In the present study we compared hand sharpening using an Arkansas and an India stone versus commercially available power driven devices [Hu Freidy Side Kicks and InstRenew by Nordent. The only objective components of sharpness represented by the bevel and the presence of WE were evaluated , because sharpness itself cannot be quantified. Using a SEM analysis at 500X magnification allows precise evaluation of the cutting edge bevels as well as detection of any wire edges. Standardization of the dulling technique was also achieved according to Moses et al to ensure similar dulling of all edges. [13]

Two types of sharpening techniques were compared in the presence study comprising two types of stones used for manual sharpening and two types of power-driven sharpeners, which are the SideKicks [Hu

Friedy] and InstRenew [Nordent] sharpeners. Statistical analysis revealed that different sharpening techniques had significantly different effects on the sharpness of cutting edges [p<0.05].

With respect to the manual sharpening stones, analysis of the results demonstrated Arkansas stone to have the least mean score , denoting best sharpening results, followed by India stone which is in line with previous studies which showed that the synthetic stones are more abrasive and produce more irregular cutting angles, whereas Arkansas stones are less abrasive and produce smoother and more defined cutting angles between the faces [14]. It was stated that Arkansas stone is made up of fine particle size leading to the production of sharper and smoother edge in comparison to the coarser grit or abrasiveness of India stone [13].Our findings however are inconsistent with Huang and Tseng who concluded that India stones produce the best sharpening results under SEM in comparison with other techniques [15].

No statistical significant difference were found between manual sharpening stones in group II and IV, and factory sharpening group I. Although no defects in the cutting angle could be noticed in factory sharpening group in this study, a bevel was seen between coronal and lateral faces recommending the use of a fine grit stone for optimum sharpness. Nevertheless some clinicians have a general assumption that brand new scalers should only be sharpened after treatment or in case of dulling [16].

On the other manual sharpening techniques were superior to power-driven sharpeners in this study, which is in line with previous findings, where hand sharpening was found to be more effective than machine sharpening, the latter exhibiting WE and ill-defined angles.. Both power-driven sharpeners resulted in ill-defined cutting angles with bevel formation between coronal and lateral faces. The results of the present study are in agreement with the fact that machine-resharpend scalers tend to produce non-functional WE caused by the reciprocative grinding on the facial surfaces of the scalers [9, 12].

Coarser stones and power driven devices can sharpen a dull instrument within less time than the fine grit stones. However, it is not recommended to allow the instruments to dull completely . Therefore, sharpening the scalers using a finer stone and two or three sharpening movements is advised to maintain a high quality cutting edge. Totally dull or very deformed instruments may be initially sharpened with a coarse stone followed by a fine stone to remove all irregularities caused by the use of the coarser one.

It is worth mentioning that the lack of an objective measure of the sharpness and the sole relying on the photographs could affect the outcome and reproducibility of the results.

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CONCLUSIONS

Within the limitation of this study, the following could concluded:

1. The manual sharpening technique [Groups III and IV] demonstrated better cutting angle with a precise or a slightly irregular angle than the power driven devices , which revealed a high frequency of bevel formation and a highly irregular cutting edges.
2. Finer stones resulted in a better quality cutting edge with fewer wire edges in comparison to the more coarse stones.

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