

COMPARATIVE *IN VITRO* STUDY OF ROOT ROUGHNESS AFTER INSTRUMENTATION WITH ULTRASONIC AND DIAMOND TIP SONIC SCALER

ESTUDO COMPARATIVO IN VITRO DA RUGOSIDADE RADICULAR APÓS INSTRUMENTAÇÃO COM ULTRASSOM E PONTAS SÔNICAS DIAMANTADAS

Fernanda Vieira RIBEIRO¹, Renato Correa Viana CASARIN¹, Francisco Humberto NOCITI JÚNIOR², Enilson Antônio SALLUM², Antonio Wilson SALLUM³, Márcio Zaffalon CASATI⁴

1- DDS, fellowship, Department of Prosthodontics and Periodontics, Division of Periodontics, Piracicaba Dental School, University of Campinas - UNICAMP.

2- DDS, MS, PhD, Associate Professor, Department of Prosthodontics and Periodontics, Division of Periodontics, Piracicaba Dental School, University of Campinas - UNICAMP.

3- DDS, MS, PhD, Titular Professor, Department of Prosthodontics and Periodontics, Division of Periodontics, Piracicaba Dental School, University of Campinas - UNICAMP.

4- DDS, MS, PhD, Assistant Professor, Department of Prosthodontics and Periodontics, Division of Periodontics, Piracicaba Dental School, University of Campinas - UNICAMP.

Corresponding address: Márcio Zaffalon Casati (corresponding author) - e-mail: casati@fop.unicamp.br - Av. Limeira 901 - Areião Caixa Postal: 052 - Cep.: 13414-903 - Piracicaba - S.P. - Brazil / Fone: 00 55 19 3412-5301/ Fax: 00 55 19 3412-5218

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ABSTRACT

Objective: The purpose of this study was to evaluate the root surface roughness after instrumentation with hand curette and diamond-coated sonic and universal ultrasonic tips. Materials and Methods: Forty root surfaces of human teeth were randomly assigned to four treatment groups: control group (without instrumentation), curette instrumentation, ultrasonic instrumentation with universal tip and sonic instrumentation with diamond-coated tip. Each sample was instrumented with fifteen strokes. Before and after instrumentation, surface roughness was measured. In addition, the root surface topography was examined after treatment under the scanning electron microscope. Results: Significant statistical differences ($p < 0.05$) were observed when comparing the control group (0.48 ± 0.07 mm) to the treated groups (hand - 1.246 ± 0.279 mm, ultrasonic - 1.468 ± 0.177 mm and sonic instrumentation - 1.576 ± 0.20 mm). The highest roughness was produced by diamond-coated sonic tip and by ultrasonic universal tip ($p > 0.05$). Conclusion: The diamond-coated tip with sonic scaler instrumentation and ultrasonic instrumentation produce similar root surface roughness, higher than curette instrumentation.

Uniterms: Dental calculus; Dental plaque; Instrumentation; Dental scaling; Root planning; Microscopy electron scanning.

RESUMO

Objetivo: O objetivo do presente estudo foi avaliar a rugosidade radicular obtida após instrumentação por aparelho sônico com pontas diamantadas, curetas e ultrassom. Material e Métodos: Quarenta superfícies radiculares, devidamente polidas e incluídas em resina acrílica, foram divididas em 4 grupos de tratamento: grupo controle (sem instrumentação) e instrumentação com cureta Gracey 5/6, ultrassom ou aparelho sônico com ponta diamantada. Em cada amostra foram realizados 15 movimentos de raspagem. Antes e após esta instrumentação foi utilizado um rugosímetro para a medição da rugosidade radicular. Além disso, a topografia da superfície radicular foi avaliada após o tratamento com microscopia eletrônica de varredura. Resultados: Diferenças estatisticamente significantes ($p < 0.05$) foram observadas ao se comparar o grupo controle (0.48 ± 0.07 mm) aos grupos tratados (cureta - 1.246 ± 0.279 mm, ultrassom - 1.468 ± 0.177 mm e aparelho sônico com ponta diamantada - 1.576 ± 0.20 mm). As maiores rugosidades foram produzidas pela ponta sônica diamantada e ponta universal de ultrassom ($p > 0.05$). Conclusão: A instrumentação sônica com pontas diamantadas promove uma rugosidade radicular equivalente à instrumentação com ultrassom, sendo essa rugosidade superior àquela apresentada pela instrumentação manual.

Unitermos: Cálculo dentário; Placa dentária; Instrumentação; Raspagem dentária; Aplainamento radicular; Microscopia eletrônica de varredura.

INTRODUCTION

The removal of dental plaque, calculus, and altered cementum by scaling and root planing is fundamental in periodontal treatment¹⁹. However, complete removal of subgingival calculus with hand or machine instruments is difficult to achieve, even when a surgical approach is used³. The ultimate objective of all root treatment procedures is to render the treated root surface biologically compatible with host periodontal tissues⁸.

The use of ultrasonic and sonic scalers in periodontal therapy has been studied since the 1950s. These instruments have shown many advantages such as reduced instrumentation time spent per tooth⁵ and better accessibility in furcation defects⁷. Recently, many tip designs for ultrasonic and sonic scalers have been modified to provide better access and instrumentation^{6,15}.

Diamond-coated sonic inserts improve access to furcations, and reduce the average treatment time^{1,14,15,16,17}. Despite the advantages described, many studies have shown that diamond-coated sonic inserts removed more tooth structure than conventional sonic scaler inserts^{13,14,15,18}. These observations suggest that the diamond-coated sonic scaler tips can damage the root surface if improperly handled.¹³

The ideal goal of periodontal instrumentation is to effectively remove plaque and calculus without causing root surface damage. Studies evaluating differences in root surface alterations due to hand, sonic, and ultrasonic instruments are inconclusive^{24,28}. Furthermore, there are few studies regarding root surface roughness caused by diamond-coated sonic scaler tips after instrumentation.

Therefore, the aim of this *in vitro* study was to evaluate the root roughness caused by diamond-coated sonic instrument tips, hand curette and ultrasonic universal tips.

MATERIAL AND METHODS

Collection of Experimental Sample

Forty mandibular and maxillary premolars extracted for orthodontics reasons were selected for this study. All teeth were extracted after written informed consent of the patients (Resolution no. 196/96 from the National Health Council, Brazilia, DF, 10/03/1996). After extraction, teeth were rinsed with water for approximately 60 seconds and placed in 10% formalin.

Selection Criteria

All teeth had to meet the following criteria: intact root surface, caries free, negative history of periodontal involvement, clean and free of gross soft and hard debris and unaltered by extraction procedure. The final selection was made at 4x magnification through a stereomicroscope and teeth with excessive root concavities or convexities were excluded.

Mounting Procedure

The crowns of the teeth were removed and each root was mounted in a 2cm high plastic tube filled with acrylic resin (Jet Classico, São Paulo – SP, Brazil) with one root face exposed. Before the instrumentation, roots were polished to reach a similar roughness for all samples. The mounted teeth were numbered from 1 to 40 and randomly assigned to one of the four study groups. To avoid reading location errors a 3x3mm area in each root was delimited as the reading area.

Pre instrumentation roughness reading

Surface roughness was measured with a surface roughness measuring instrument (Surf-Corder SE 1200 Kosaka Laboratory Ltd.) at 0.1mm/sec reading speed following the ANSI standard. Each root received 6 roughness readings (3 parallel and 3 perpendicular to the scaling) to determine a mean roughness for each tooth.

Root Scaling

The root surfaces were treated by the same operator using one of the following instruments: 1) Gracey hand curettes 5/6 (Gracey curette 5/6, Hu Friedy, Chicago, USA), 2) ultrasonic scaler (Dabi Profi III–Bios, Dabi Atlante, Ribeirão Preto, SP, Brazil) -power setting at medium with universal tip (9Q, Dabi Atlante, Ribeirão Preto, SP, Brazil) and 3) sonic scaler (Sonicborden2000N®, KaVo, Biberach, Germany) with diamond-coated sonic instrument tip (Sonicflex® rootplaner, KaVo, Biberach, Germany). The control group has not received any treatment.

Groups treated with curettes received 15 apical to coronal strokes, parallel to the axis of the tooth. The curette was resharpener with a sharpening stone (Arkansas stone No.6A, Hu-Friedy, Leimen, Germany) after each five strokes. The groups treated with ultrasonic and sonic scalers received 15 apical to coronal strokes with an inclination of zero degree of the tip⁹.

Post instrumentation roughness evaluations

A roughness reading (Surf-Corder SE 1200 Kosaka Laboratory Ltd.) was performed again on all treated roots to determine a mean roughness for each treated root surface. Four samples of each group were selected for scanning electron microscopy (SEM) (JEOL JSM-T330A, Japan) with a magnification of 100X. The images acquired were used for descriptive analysis.

Statistical analysis

Differences in roughness means after instrumentation were evaluated by analysis of variance (ANOVA) and by the Tukey test ($\alpha=0.05$).

RESULTS

Roughness

Differences in root roughness among all groups before treatment were not statistically significant. Therefore, all specimens showed, before instrumentation, similar

smoothness in root surfaces due to the standardized preparation.

All treated groups showed a significant increase in roughness ($p < 0.05$) compared to the control group ($0.485 \pm 0.076\text{mm}$). Significant statistical differences were found when hand instrumentation was compared ($1.246 \pm 0.279\text{mm}$) to ultrasonic ($1.468 \pm 0.177\text{mm}$) and sonic ($1.576 \pm 0.20\text{mm}$) treatments ($p < 0.05$). The diamond-coated sonic tips created the roughest surface; however, this roughness was not significantly different when compared with roughness created by the ultrasonic scaler (Table 1).

Microscopy Descriptive Analysis

The SEM images showed a smooth and polished root surface in the control specimens (Figure 1). After instrumentation, differences could be observed in the surface topography of treated groups. All treated surfaces showed an irregular aspect, different from non scaled root surfaces. The treated surfaces after instrumentation, independently of the experimental group, revealed that dental tissue was removed along the entire instrumentation stroke (Figure 2, 3, 4).

Hand curette instrumentation produced the smoothest surfaces among the treated groups. In this group, grooves were observed following the same direction of the scaling movements and less roughness was found when compared to ultrasonic and sonic groups (Figure 2).

The surfaces after instrumentation with the ultrasonic group showed the presence of deeper sulcus and a rough surface (Figure 3). In the ultrasonic group and sonic scaler with diamond-coated tips group, irregular scratching was found in all surfaces (Figures 3, 4). Both of these instruments produced uneven surfaces marked with scratches due to the vibrating movements of machine scalers (Figures 3, 4).

The group instrumented by sonic scaler with diamond-coated tips also showed a rough surface caused by scaling (Figure 4). The diamond coating caused an irregular aspect because of the grinding action. The diamond splinters give the tool a multitude of edges, and every individual cutting grain forms part of the multifaceted tool, which leaves a characteristic roughness, as illustrated by SEM images (Figure 4).

DISCUSSION

According to the present study, the roughness reading and the SEM examinations showed that all treated groups presented a significant increase in roughness compared with the control group and demonstrated that the diamond-coated sonic tip and ultrasonic universal tip caused increased roughness when compared to hand currettes.

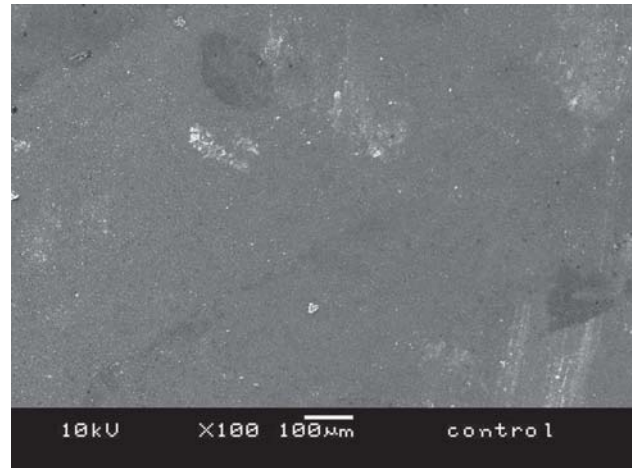


FIGURE 1- Micrograph of not scaled root surface. Note the root surface smoothness. Original magnification 100x

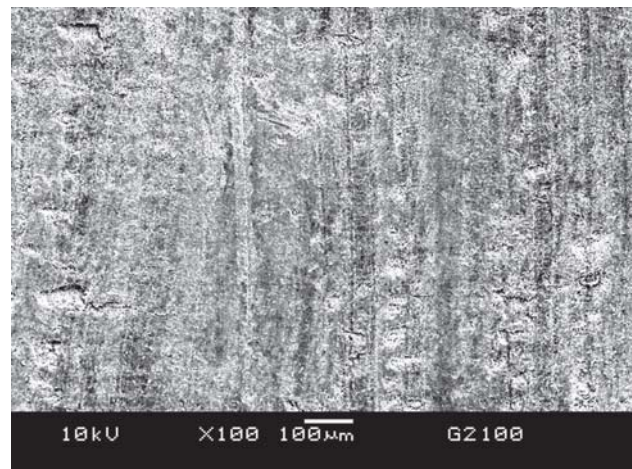


FIGURE 2- Micrograph of curette group root surface. Note the gouges that correspond to the curette tip and scratches in the stroke direction. Original magnification 100x

TABLE 1- Comparison of all control and treated groups showing mean values and standard deviation of roughness after instrumentation

Group	Treatment	Mean
G1 (n=10)	Control	0.485 ± 0.076 C
G2 (n=10)	Curette	1.246 ± 0.279 B
G3 (n=10)	Ultrasonic scaler/universal tip	1.468 ± 0.177 A
G4 (n=10)	Sonic scaler/diamond-coated tip	1.576 ± 0.204 A

Mean values followed by different letters exhibited statistical difference ($p < 0.05$)

Previous studies have evaluated differences regarding the roughness produced by sonic, ultrasonic and hand instruments^{10,24}. However, the angulation and design of instrument tip, sharpness of the working edge, the length of time the instrument is in contact with the root, and the cumulative number of strokes have impact on the degree of root damage and this situation can be explained by the lack of standardization.

Furthermore, the Roughness Loss of Tooth Substance Index (RLTSI) has been used by some studies^{10,12,24}, but the loss of tooth substance of a specific instrument cannot be directly correlated with its produced roughness^{13,30} and a separate evaluation of tooth substance loss and surface roughness produced is necessary³⁰. Therefore, considering all these variables in previous studies, it is difficult to come to a conclusion regarding the method of instrumentation that causes the least amount of root surface alterations.

In the present study, differences in surface roughness have been found among different instruments, although it

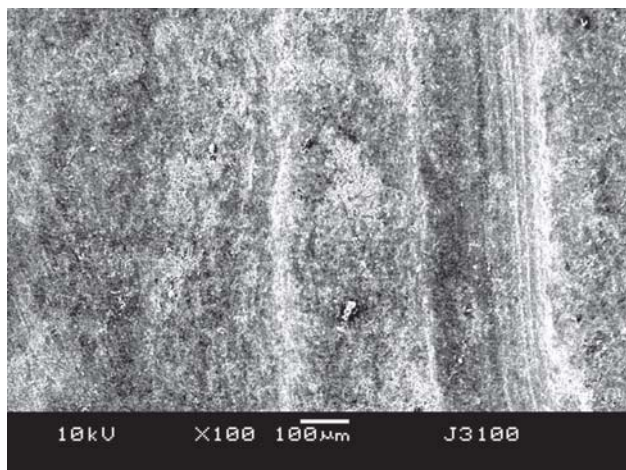


FIGURE 3- Micrograph of root surface instrumented by ultrasonic scaler. Note the rougher surface. Original magnification 100x

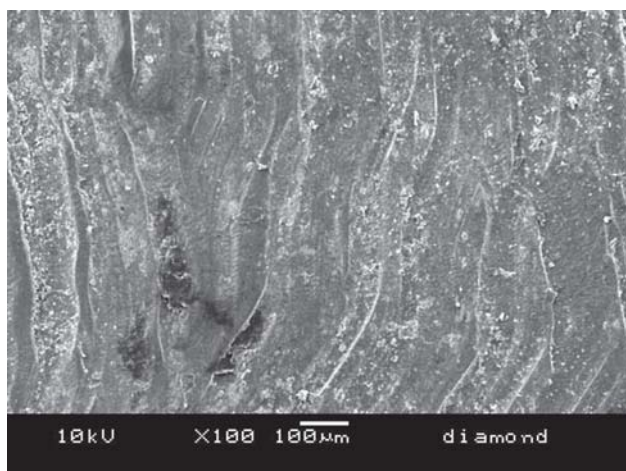


FIGURE 4- Micrograph of root surface produced by sonic instrumentation with diamond-coated sonic instrument tip. Note the irregular aspect caused by diamond coating. Original magnification 100x

remains to be determined whether these differences are of clinical significance. To understand the issue of roughness created after debridement and the success of periodontal treatment, different aspects have to be distinguished: supragingival or subgingival roughness and supragingival plaque control during healing.

Studies have demonstrated that the most important prerequisite for healing after periodontal treatment is a root surface free of plaque and calculus²⁹. Mierau²⁵ (1984) and Quirynen and Bollen²⁷ (1995) have clarified that supragingival rough surfaces subsequent to professional instrumentation can promote plaque formation and contribute to bacterial adhesion. Supragingival surface roughness and surface irregularities increase the surface area, promote bacterial colonization, plaque formation and thereby can compromise daily plaque removal^{20,23}.

Concerning subgingival roughness, some studies demonstrated that changes over subgingival root topography did not interfere with the response to periodontal treatment^{4,28}. Rosenberg and Ash²⁸ (1974) did not find that the different instruments had a significant effect on histologically assessed healing. Khatiblou and Ghodossi¹¹ (1983) have reported that periodontal healing following flap surgery occurs regardless of whether the subgingival root surface is rough or smooth. These results were confirmed by Oberholzer and Rateitschak²⁶ (1996), who have found no difference in pocket reduction and clinical attachment gain after creating rough or smooth surfaces during a flap operation. This indicates that subgingival roughness does not interfere with healing if there is a good supragingival plaque control. In an animal experiment, subgingival roughness following surgery, without supragingival plaque control during healing, favored plaque retention and colonization²¹. Leknes, et al.²² (1996) demonstrated that roughness resulting from subgingival instrumentation significantly influenced the subgingival microbial colonization. Then, a smooth root surface may be advantageous near the gingival margin, since a smooth surface is less likely to accumulate plaque than a rough surface.

Therefore, for clinical application, it can be assumed that a meticulous scaling and root planing procedure during initial cause-related therapy should be performed³⁰ and the long-term success of this treatment is dependent on the quality of the maintenance therapy².

Although there are many advantages of using power-driven scalers and diamond-coated sonic tips instead of hand curettes^{1,14,15,16,17}, the present study showed that diamond-coated sonic tips produced rougher root surface than curettes. Even though a clinical evaluation has not been conducted in the current investigation, according to the findings of this study and based on the *in vivo* evidences^{2,13,20,21,23,27}, it can be suggested that caution should be important when utilizing this instrument and that a higher standard of supragingival oral hygiene of the patient can be required. More studies are needed to clarify the influence of diamond-coated sonic tips on root surface roughness.

CONCLUSION

Within the limits of the present study, it can be concluded that diamond-coated sonic tips and ultrasonic universal tips produce a similar roughness surface that is higher than that produced by hand curettes.

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