Research Article

Evaluation of Root Surface Changes following Manual and Ultrasonic Instrumentation of Periodontally Involved Teeth by Scanning Electron Microscope - An In Vitro Study

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ABSTRACT

Introduction: Scaling and root planing is essential in periodontal treatment. Manual scaling and root planing can often be difficult and time consuming due to the complex and unfavorable root morphology. The development of power driven mechanical instruments have shown advantages. The ultimate objective of all root treatment procedure is to render the treated root surface biologically compatible with the host periodontal tissues. Precise study of the root surface can be performed only by means of SEM. This study was undertaken to evaluate the root surface changes following manual and ultrasonic instrumentation using SEM.

Objective: To evaluate and compare the efficiency and effectiveness of root planing instruments namely, Gracey curette and micro ultrasonic insert on the root surface of periodontally involved teeth by SEM evaluation.

Materials and Method: Fifty anterior teeth with comparable amounts of subgingival calculus and a probing depth of 5-10 mm and indicated for extraction were enrolled in the study. Ten teeth were considered as controls, 20 teeth were instrumented with micro ultrasonic insert for a time period of 2 minutes and 20 teeth were instrumented with Gracey curette for a time period of 5 minutes. The instrumented root surfaces were assessed for the amount of remaining calculus and roughness and loss of tooth substance using SEM. For statistical analysis, the collected data were entered into the computer data base and analyzed using SPSS.

Result: The difference in the amount of remaining calculus on the root surfaces instrumented with Gracey curette and Micro ultrasonic insert was negligible. Surface roughness and loss of tooth substance was slightly higher for root surfaces instrumented with micro ultrasonic insert compared to Gracey curette.

Conclusion: Both Gracey curette and micro ultrasonic insert were effective in achieving adequate root debridement. The difference in the amount of remaining calculus and roughness and loss of tooth substance was not statistically significant between the root surfaces instrumented with Micro ultrasonic insert and Gracey curette.

Keywords: Gracey curette; microultrasonic insert; SEM.

INTRODUCTION

The removal of dental plaque, calculus and altered cementum by scaling and root planing (SRP) is fundamental in periodontal treatment.[1] Manual SRP can often be difficult and time consuming due to the complex and unfavorable root morphology when working blindly at deep pocket sites.[2] Therefore development of power driven mechanical instruments have shown advantages such as reduced instrumentation time spent per tooth[3] and better accessibility in furcation areas or defects.[4] Precise study of the root surface can be performed only by means of scanning electron microscope (SEM).[5] The ultimate objective of all root treatment procedure is to render the treated root surface biologically compatible with the host periodontal tissues.[6] How effective ultrasonic powered scaling instrument tips, as compared to manual curettes have always been a topic of much discussion and controversy.[7]

In this study, teeth with poor periodontal prognosis were extracted and the root changes were systematically examined by SEM for the presence of residual bacteria and calculus.This study was undertaken to evaluate the root surface changes following manual and ultrasonic instrumentation of periodontally involved teeth using SEM.

MATERIALS AND METHOD

The present study was conducted in the Department of Periodontics, Manipal College of Dental Sciences, Mangalore. Periodontally affected 50 anterior teeth with poor prognosis were extracted and divided into three groups. The study sample consisted of 18 male and 13 female patients aged between 24 to 60 years. A thorough medical, dental history and prior informed consent were obtained from each patient and a detailed clinical examination including an intraoral periapical (IOPA) radiograph were taken. Patient information sheet regarding the study was also given. **Exclusion Criteria:** Patients who have undergone periodontal therapy in the past 6 months and teeth with carious lesions or restorations on the root surfaces. **Inclusion Criteria:** Patients with periodontally affected single rooted teeth with poor prognosis which needed extraction were included in the study and the teeth with pocket depth and loss of attachment of = 5mm. The teeth selected for the study had probing depths ranging from 5 to 10mm which was measured using William's Periodontal Probe. IOPA radiograph was taken for each tooth to assess the bone level around the tooth. All the teeth selected for the study had at least a score of 2 or more according to oral hygiene index by Greene and Vermillion. Gracey curette #1-2 (Hu-Friedy) designed by Dr. Clayton H. Gracey in 1930s and Cavitron micro ultrasonic inserts by Dentsply were evaluated in this study. Following infiltration anesthesia with 2% lignocaine with 1:200000 adrenaline, the instruments were used in the mouth of the patients in a manner consistent with the standards SRPprocedures. An attempt was made to maintain the sharpness of the curette by sharpening before each instrumentation. The selected teeth were then divided into three groups and were extracted atraumatically using extraction forceps.

In Group I, 10 teeth were selected and no treatment was performed and were considered as controls. Controls were used to determine the amount of calculus present on the root surfaces.[8]

In Group II, 20 teeth were selected and subgingival SRPwas performed for each tooth using Gracey curette #1-2 for a time period of 5 minutes.[8,9,10] In Group III, 20 teeth were selected and subgingival SRP was performed for each tooth using micro ultrasonic insert (Dentsply) for a time period of 2 minutes,[2] with the power being set at levels as per manufacturers' instructions. The stopwatch was used to record the time of instrumentation. All the patients were treated by the same operator. Following extraction the teeth were rinsed in normal saline to remove any blood or soft tissue tags and was stored in buffered formaldehyde.[11] The samples were then dehydrated in ascending strengths of ethanol to 100%, air dried for 24 hours and mounted on brass metal stubs. This procedure was followed by gold sputtering with a JEOL-JFC-1100E ion-sputtering device. The samples were examined in a JEOL-JSM-840A scanning electron microscope at Indian Institute of Sciences, Bangalore, operating at 20Kv.The sections were examined under SEM at 70X magnification. Two SEM photomicrographs were obtained for each tooth. A total of 100 SEM photomicrographs were obtained for 50 teeth. The SEM photomicrographs were graded in a scale ranging from 0-3 to evaluate the remaining calculus and roughness and loss of tooth substance by Remaining Calculus Index (RCI)12 and Roughness and Loss of Tooth Substance Index (RLTSI) respectively.

RCI in accordance with the following criteria:[12]

Grade 0 - No calculus remaining in the root surface.

Grade 1 - Small patches of extraneous material, probably consisting calculus.

Grade 2 - Definite patches of calculus confined to smaller areas.

Grade 3 - Considerable amounts of remaining calculus appearing as one or a few voluminous patches or as several smaller patches scattered on the treated surface.

RLTSI in accordance with the following criteria:

Grade 0 - Smooth and even root surface without marks from the instrumentation and with no loss of tooth substance.

Grade 1 - Slightly roughened or corrugated local areas confined to the cementum.

Grade 2 - Definitely corrugated local areas where the cementum may be completely removed, although most of the cementum is still present.

Grade 3 - Considerable loss of tooth substance with instrumentation marks into the dentin. The cementum is completely removed in large areas, or it has a considerable number of lesions from the instrumentation.

The SEM photomicrographs were also used to evaluate the remaining calculus percentage and roughness and loss of tooth substance percentage by point counting. Point counting is the most efficient method of obtaining area measurements of sections. It is quicker than drawing or linear integration and errors are easy to assess. The procedure is equivalent to dividing the tissue to be examined into very small cubes and counting the number of cubes corresponding to the various components of the tissues. Point counting was first used for histological sections by Chalkey (1943). The proportion of points lying over a feature is equal to that area proportion of that feature in the section and hence to the volume proportion in the tissue.[13]

The collected data were entered into the computer database and analysed using the statistical package SPSS in the Department of Community Medicine, Kasturba Medical College, Mangalore. Kruskal-Wallis Test was applied for group comparison and Mann-Whitney U Test was applied for intercomparison between various groups. A p value of less than 0.05 was considered as significant.

RESULT

In **Control group**, 60% showed considerable amount of remaining calculus appearing as one or few voluminous patches or several small patches scattered on the treated surface, 62.5% of **Manual group** showed small patches of extraneous material probably consisting of calculus and 70% of **Micro Ultrasonic Insert** group showed no calculus on the root surface (Table 1).The difference in RC percentage between control and manual was -2.952 was highly statistically significant (P<0.001). The difference in RC percentage between control and ultrasonic was -3.586 was statistically highly significant (P<0.001). The difference in RC percentage between manual and ultrasonic was -0.210 was statistically not significant (P>0.05)(Table 2).

In **Control group**, 90% showed smooth and even root surface without marks from the instrumentation and with no loss of tooth substance. In **Manual group**, 42.5% showed slightly roughened corrugated local areas confined to cementum and 42.5% in **Micro Ultrasonic Insert** showed slightly roughened corrugated local areas confined to cementum (Table1).

The difference in **RLTS percentage** between control and manual was -2.225 was statistically significant (P<0.05). The difference in RLTS percentage between control and ultrasonic was -2.446 was statistically significant (P<0.05). The difference in RLTS percentage between manual and ultrasonic was -0.756 was statistically not significant (P>0.05) (Table 2).The mean **RC percentage** for combined in Controls (Group I) was 41.21, while the mean RC percentage for combined in Group II was 7.51 and in Group III was 5.02(p=0.00 hs) (Table 3). The mean RLTS percentage in Controls (Group I) was 0.71, while the mean RLTS percentage in Group II was 6.31 and in Group III was 18.41 (p<0.01 hs) (Table 3).

DISCUSSION

Calculus, a secondary etiologic factor facilitates plaque formation and retention by virtue of its tenacious attachment to the root surface.[14] The complete removal of plaque and calculus from the root surface is an essential component of non-surgical, surgical and supportive periodontal therapy.[11]

Mechanical debridement of subgingival root surface can be accomplished by use of hand, sonic or ultrasonic instruments.[15] Debridement of root surface significantly reduces gingivitis, tooth loss, attachment loss, severity of disease and probing depth along with improvement in other clinical parameters.[16] SRP is the procedure considered fundamental to successful therapy.[8] SRPmechanically disrupt the smear layer on treated root surfaces.[11] Hand instruments in particular the curettes remain the gold standard for instrumentation of subgingival root surfaces.[8] The power driven instruments provide the advantageof allowing one to achieve a highly efficient and time saving removal of plaque and calculus with less effort.[2] However, the bulky design of P10 ultrasonic insert may impede complete removal of plaque and calculus when mean pocket depth exceeds 5 mm.[17]

The present study was envisaged to compare the efficiency of micro ultrasonic inserts with that of Gracey curettes. The study population consisted of 18 male and 13 female patients in whom 50 anterior teeth with comparable amounts of subgingival calculus and a probing depth of 5-10mm indicated for extraction were enrolled in the study. Previous studies have shown that anterior teeth with pockets upto 5mm can be successfully root planed non-surgically, whereas in posterior teeth with root debridement with direct vision is more successful.[5] In the present study we have evaluated the efficacy of Hu-Friedy Gracey curette# 1-2 with micro ultrasonic insert. The time limit instrumentation was set as 5 minutes for Gracey curette and 2 minutes for micro ultrasonic insert. This criteria was the same as followed by previously reported studies.[2,8-10]

Standardization of experimental conditions is difficult to achieve. Several studies have therefore been performed in pure in vitro conditions. The results of such studies cannot however be directly related to the clinical situation. However, because of few vivo studies, the result of the present study have been compared to both invivo and invitro studies.[1]

Teeth were extracted immediately after treatment in our study to observe the surface characteristics of the root planed surfaces. However, precise study of the root surface can be performed by means of SEM.[18]

Scanning Electron Microscope Examination: SEM is an effective tool to observe the changes on the root surface as it can scan the surface topography at low and high magnifications.[19] The amount of remaining calculus and roughness and loss of tooth substance was based on visual inspection of standardized photomicrographs and scored according to the defined criteria of remaining calculus index[12] and roughness and loss of tooth substance index.

Remaining Calculus Percentage: SEM assessment for the remaining calculus showed that the mean RC percentage for the Controls (Group I) was 41.2. The mean RC percentage for the Ultrasonic (Group III) was 5.02. The difference of RC percentage between the Controls (Group I) and the Ultrasonic (Group III) was statistically highly significant ($p<0.001$).The mean RC percentage for Gracey curette(Group II) was 7.51. The difference in RC percentage between Control and Manual was -2.952, statistically highly significant($p<0.001$). Even though mean RC percentage for Gracey curette was slightly higher compared to mean RC percentage of ultrasonic, the difference in RC percentage between manual and ultrasonic was not statistically significant. These results agree with previous in vivo studies.[20] The surface of residual calculus varied from granular to burnished.

The Control were used in the study to differentiate the amount of calculus present on the root surfaces.[21] The difference in mean RC percentage between ultrasonic insert and Gracey curettes can be attributed to design of Micro ultrasonic insert which is more efficacious in reaching close to the bottom of the pocket (0.78). This gives credence to their design because these inserts more favorably simulate the size and shape of the diagnostic periodontal probe and is more efficacious in removing the subgingival irritants.[20]

Roughness and Loss of Tooth Substance Percentage: If the operator gouges the root surface while attempting to remove the subgingival irritants, a new environment may be created for the retention of future subgingival irritants. Instruments used to mechanically prepare root surfaces should not damage, gouge, trough or remove judicious amounts of tooth structure.[20] In the present study, we have measured the roughness and loss of tooth substance created by instrumentation.The mean RLTS percentage for Controls (Group I) was 0.71. The mean RLTS percentage for Group III was 18.41. The difference in RLTS percentage between control and ultrasonic was

Table 1: Comparison of percentage of grading of remaining calculus index and roughness and loss of tooth substance index between three groups of the study.

RCI Grading	CONTROL (Group I)	MANUAL (Group II)	ULTRASONIC (Group III)
0	2(10.0%)	9(22.5%)	28(70.0%)
1	2(10.0%)	25(62.5%)	12(30.0%)
2	4(20.0%)	5(12.5%)	0
3	12(60%)	1(2.5%)	0
RLTSI Grading			
0	18 (90.0%)	16 (40.0%)	9(22.5%)
1	2(10.0%)	17(42.5%)	17(42.5%)
2	0	6(15.0%)	11(27.5%)
3	0	1(2.5%)	3(7.5%)

Table 2: Statistical comparison of remaining calculus percentage and roughness and loss of tooth substance percentage between three groups of the study.

		Group I Vs Group II	Group I Vs Group III	Group II Vs Group III
Remaining Calculus (RC) percentage	Z	-2.952	-3.586	-1.210
	P	0.018SIG	<0.001VHS	0.440
Roughness and loss of tooth substance (RLTS) percentage	Z	-2.225	-2.446	-0.756

Table 3: Remaining calculus percentage and roughness and loss of tooth substance percentage.

	Number	Mean	H	P
RC percentage				
Group I	20	41.2115	28.82	0.001VHS
Group II	40	7.5150		
Group III	40	5.0250		

	Number	Mean	H	P
RC percentage				
Group I	20	0.7100	13.32	0.01VHS
Group II	40	6.3175		
Group III	40	18.4175		

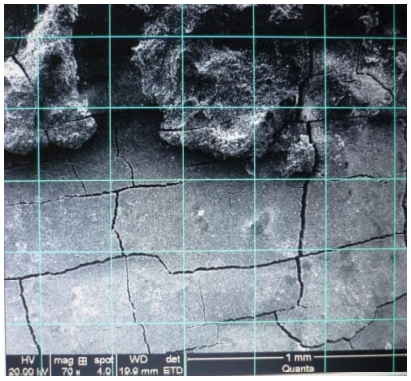

Figure 1: Point counting on SEM image of control group. The magnification of this and all the other SEM illustrations is X70. Relatively smooth surface with moderate amount of calculus.

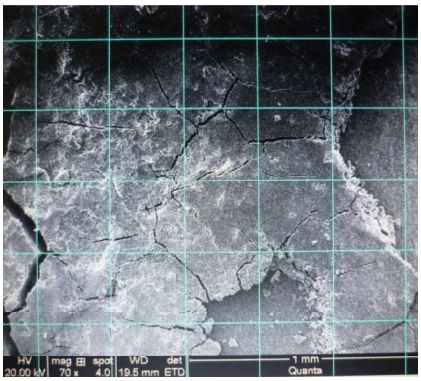

Figure 2: Point counting on SEM image of manual group. Several spalling areas with some loss of tooth substance has been removed and small amount of remaining calculus.

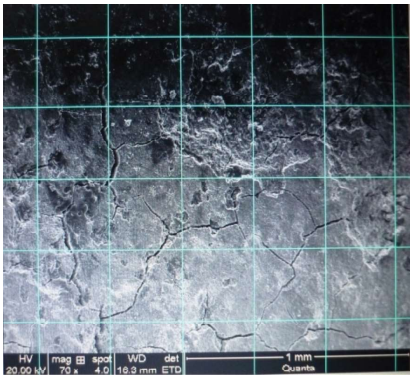

Figure 3: Point counting on SEM image of ultrasonic group. Scattered spalling areas. No remaining calculus.

statistically significant ($p<0.05$). The mean RLTS percentage for Gracey curette (Group II) was 6.31. The difference in RLTS percentage between control and Gracey curette (Group II) was statistically significant ($p<0.05$). The difference in RLTS percentage between manual and ultrasonic was -0.756 which was not significant statistically($p>0.05$). The results agree with the previous in vivo studies.[12, 22] The results indicated that some amount of roughness and loss of tooth substance was present even on the untreated control root surfaces and roughness and loss of tooth substance was increased after instrumentation with either Micro ultrasonic insert or Gracey curette. Surface roughness by itself seems not to be of any biologic significance. Stahl et al (1981) highlights the need for the presence of a mineralized micro roughness cementum layer for initiating cementogenesis in healing process and few studies revealed that rough residual surface could obviously constitute a potential danger of colonization by periodontal pathogens.[23]

Studies have shown that the aggressive use of magnetostrictive and piezoelectric ultrasonic devices on root substance was significantly influenced by the scaler tip designs, increasing for the wider scaler tips as compared with narrow, probe shaped inserts.[24] The greater root substance removal by Micro ultrasonic insert can be attributed to the higher displacement amplitude of piezoelectric ultrasonic scaler.[25]

In our study the following parameters namely, the number of working strokes, force of application with respect to Gracey curette and micro ultrasonic insert were not standardized. This needs to be looked into in further studies. More in vivo studies with standardization of experimental condition are required for drawing definitive conclusions.

CONCLUSION

Both Gracey curette and micro ultrasonic insert were effective in achieving adequate root debridement. The difference in the amount of remaining calculus on the root surfaces instrumented with Gracey curette and micro ultrasonic insert was negligible even though SEM showed slightly higher amount of remaining calculus with respect to root surfaces instrumented by Gracey curette. Surface roughness and loss of tooth substance was slightly higher for root surfaces instrumented with micro ultrasonic insert compared to Gracey curette.The difference in the amount of remaining calculus and roughness and loss of tooth substance was not statistically significant between the root surfaces instrumented with micro ultrasonic insert and Gracey curette.

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