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Comparative evaluation of enamel and cementum morphology after scaling and root planing with curette and ultrasonic tips – an invitro scanning electron microscopic study

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Abstract

Background and objectives: Scaling and root planing is one of most commonly utilized conservative procedures for the treatment of periodontal diseases and obtain smooth surface. Although residual root roughness has a minimal effect on healing of the periodontal apparatus, it may facilitate further bacterial accumulation and subsequent calculus deposition. Therefore, the ideal instrument should enable the removal of all extraneous substances from the root surfaces without any iatrogenic effects. Thus, the present study was conducted to evaluate enamel and cementum surface characteristics following treatment with hand and ultrasonic instruments by scanning electron microscope.

Method: A total of 44 single rooted extracted teeth for moderate to severe periodontitis were collected. For study purpose, 44 extracted teeth were grouped into 4 groups with 11 teeth in each group. Group 1- Underwent scaling and root planing with gracey curette #1/2, 3/4, 5/6; Group 2- Underwent scaling and root planing with ultrasonic Universal tip (No: 1); Group 3- Underwent scaling and root planing with root debridement tip (H3); Group 4- Control without any instrumentation. After instrumentation, samples were analyzed under SEM for evaluating the enamel and cementum characteristics using Remaining Calculus Index (RCI), loss of tooth substance index (LTSI) and Roughness Loss of Tooth Substance Index (RLTSI) and. Results were statistically analyzed using One way ANOVA test.

Results: SEM analysis showed that RCI was least for ultrasonic scaling with root debridement tip "H3" followed by ultrasonic scaling with universal tip. The least LTSI noted significantly after Ultrasonic scaling with root debridement tip "H3" followed by Hand scaling. The least RLTSI was noted significantly after instrumentation performed with root debridement tip "H3" compared to hand curette and universal scaler tip no.1.

Conclusion: Ultrasonic scaling with root debridement tip "H3" can be used to minimize damage on the tooth surface during ultrasonic scaling and root planing.

Keywords: Scaling and root planing, root debridement tip "H3", scanning electron microscopy, ultrasonic scaling, hand scaling.

Introduction

Periodontal therapies help to restore and maintain healthy periodontium and may also help to control related diseases. The main goal of periodontal treatment is to obtain a biologically acceptable tooth surface. This can be achieved by the mechanical removal of supra/subgingival biofilm and calculus, which are the most prominent causes of periodontal disease. Instruments used to prepare tooth surfaces mechanically should not excessively damage, gouge, trough, or remove injudicious amounts of tooth structure. The smoothest tooth surface possible should be the goal of scaling and root planing. Tooth roughness may facilitate further bacterial accumulation and calculus formation. Excessive removal of cementum in order to remove endotoxin may lead to dentinal hypersensitivity.

Meticulous mechanical scaling and root preparation appears to be an important aspect of the treatment procedure to resolve gingival inflammation, and restore the normal tissue. Scaling and root planing with hand instruments is often difficult and time consuming, also requiring physical effort[3].

Initially periodontal therapy was started with hand instruments for mechanical removal of biofilm and calculus. Due to the difficulty in using hand scalers, the emergence of ultrasonic scalers came into existence and have become the most common and preferred instruments for this purpose[2]. The use of sonics and ultrasonic scalers in periodontal therapy has been studied since 1950's[1]. Various powered instruments are available for scaling and root planing including sonic, ultrasonic and rotary instruments. But they have disadvantage of lack of tactile sensation, or damage to tooth structure. Each of these instruments have shown clinical effectiveness, none have been proven to be more effective than others.

Ultrasonic scalers are driven by generators that convert electrical energy into ultrasonic waves by means of piezoelectric or magnetostrictive. Several studies have reported comparable clinical outcome with respect to the utilization of these scalers. However, piezoelectric is found to be more procedure sensitive gadget. Ultrasonic instruments are equipped for removal of calculus and for expelling endotoxin from tooth surface without altering tooth surface. Improper application of tips may cause gouge, trough, nick and scratch on tooth surface.

The adjustment in working parameter, and tips design has an impact on root surface roughness and on deposits removal. Working parameter including tip angulation, power setting, instrument contact time, tip design and lateral forces are relative to tooth damage. Tip design also make difference on tooth surface and deposits.

Hence, this study is designed to evaluate the efficiency of curette and piezoelectric ultrasonic tips on surface roughness, loss of tooth substance and also to evaluate efficacy in calculus removal.

Material And Methods

This study was conducted on 44 extracted single rooted teeth. Study sample consisted of 33 single rooted teeth, which was extracted due to periodontitis and 11 samples which were extracted foe orthodontic purpose were collected for control group. Samples were collected from department of oral and maxillofacial surgery, A. J. Institute of dental sciences, Mangalore.

Inclusion Criteria

1. Single rooted teeth (incisors, canines, premolars).
2. Intact root surface.
3. Teeth extracted for reasons other than caries.
4. Teeth extracted for periodontal disease (grade II or III mobility).
5. Extracted teeth without any apparent surface defects.
6. Teeth extracted for orthodontic purpose.
7. Teeth with flecks of calculus covering Enamel and Cementum.

Exclusion Criteria

1. Teeth with dental caries.
2. Teeth with cervical abrasion.
3. Deciduous teeth.
4. Teeth with prosthesis.
5. Fractured teeth.
6. Signs of external resorption.
7. Erosion of teeth.
8. Root surface caries or any subgingivally placed restorations.
9. Periodontal treatment for past 6 months.

44 single rooted extracted teeth for moderate to severe periodontitis were collected from Department of Oral and Maxillofacial Surgery. For study purpose, 44 extracted teeth were grouped into 4 groups with 11 teeth in each group, ensuring that there was similar amount of surface calculus, as assessed by naked eye[25], except in the control group as it was calculus free teeth and it was extracted for orthodontic purpose.

Allocation to the groups

The test group extracted teeth were subjected to one of the following modes of treatment:

Group 1 – Scaling and root planing with gracey curette #1/2, 3/4, 5/6.

Group 2 – Scaling and root planing with ultrasonic Universal tip (No: 1)

Group 3 – Scaling and root planing with root debridement tip (H3)

Group 4 – Control without any instrumentation. (Teeth without any visible calculus)

Experimental Procedure

Immediately after extraction, teeth were rinsed in running tap water and soft tissue attached to the tooth was removed, following these teeth were fixed with 10% formaldehyde. Then teeth were mounted on a 2cmX 2cm block of acrylic with apical 1/3rd of the tooth immersed in the block. The mounted teeth were randomly assigned to 3 groups. To avoid reading location errors, a 4x4mm area in each tooth (enamel and cementum) was delimitated as the reading area.

Instrumentation zone/ working zone determination

The buccal cemento-enamel junction (CEJ) of all teeth were detected using an explorer. A groove was made 4mm apical and coronal to the CEJ. This was taken as the instrumentation zone or the working zone, which included 4mm of Enamel and 4mm of Cementum.

The Tooth Surfaces Were Treated Using One of The Following Methods

Group I: Scaling and root planing with curette:

Scaling and root planing was carried out at grooved area with Gracey curettes No: 1/2, 3/4, 5/6, using modified pen grasp, with apico-coronal strokes till adequate

smooth, hard root surface is visible, without calculus. Evaluation was done with an explorer

Group II: Scaling and root planing with ultrasonics (SATELEC)

Scaling and root planing was carried out at grooved area with back-and-forth stroke, in a sweeping motion. Instrumentation was done using Universal tip (No: 1) with medium power setting and with the use of water cooling (as per manufacturer's instruction).

Group III: Scaling and root planing with ultrasonics (SATELEC)

Scaling and root planing was carried out at grooved area with back-and-forth stroke, in a sweeping motion. Instrumentation was done using root debridement tip (H3) with medium power setting and with the use of water cooling (as per manufacturer's instruction).

Group IV: No instrumentation was carried out as it is calculus free and regarded as **Control group.**

Prior to the Scanning Electron Microscope (SEM) Evaluation, the teeth were detached

from the acrylic base using diamond disc bur with airotar handpiece.

Scanning Microscope Analysis

Evaluation was done at the Department of Scanning Electron Microscopy, NITK, Surathkal. The specimens were then examined using a Scanning electron microscope. Standardised photomicrographs of the selected sites will be obtained at magnifications of 50X,100X,500X and 1000X.

Specimen preparation for Scanning Electron Microscope analysis:

Steps involved in Scanning Electron Microscope analysis are as follows:

1. Gold sputtering
2. Teeth mounted in Scanning Electron Microscope machine
3. Vaccumization
4. Image processing

Method of Evaluation

Based on Scanning Electron Microscope evaluation, the amount of remaining calculus, roughness, and loss of tooth substances will be recorded using the following indices:

Remaining calculus index (RCI): [Lie and Meyer, 1977][10]

0: No calculus remaining on the root surface

1: Small patches of extraneous material, probably consisting of calculus

2: Definite patches of calculus confined to relatively small areas

3: Considerable amount of remaining calculus, appearing as one or a few voluminous patches or as several smaller patches scattered on the treated surface

Loss of tooth substance index (LTSI): [Lie and Meyer, 1977][10]

0: No detectable loss of tooth substance

1: Slight loss of tooth substance restricted to localized areas; most of the cementum intact

2: Definite loss of tooth substance on most of the treated surface, but without deep instrumental marks in the dentin; cementum may be absent in some areas

3: Considerable loss of tooth substance with deep instrumental marks in the dentin; most of the cementum is removed.

Roughness loss of tooth substance index (RLTSI): [Lie and Leknes, 1985][48]

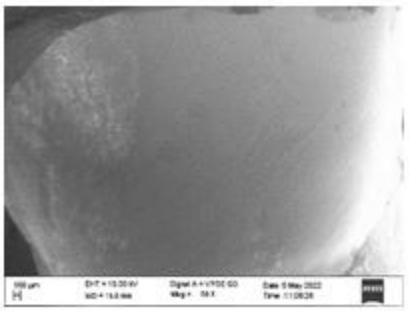
0: Smooth or even root surface, without marks from the instrumentation and with no loss of tooth substance

1: Slightly roughened or corrugated local areas confined to the cementum

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

3: Considerable loss of tooth substance, with instrumentation marks extending into the dentin. The cementum is completely removed in large areas or there are a considerable number of lesions due to the instrumentation.

GROUP I: Treated Using Hand Instrumentation



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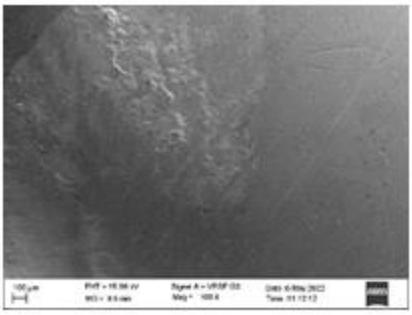

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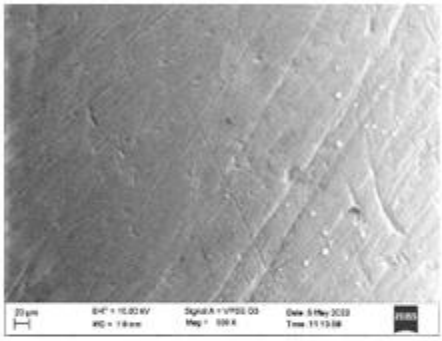

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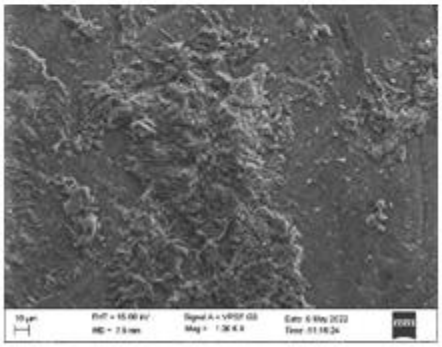

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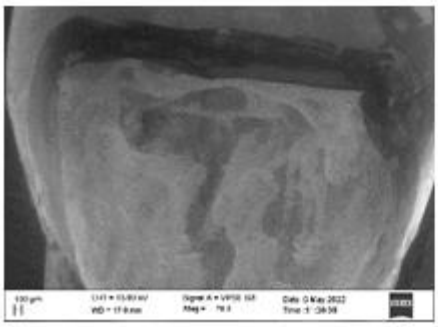
GROUP II: Treated Using Universal Ultrasonic Tip



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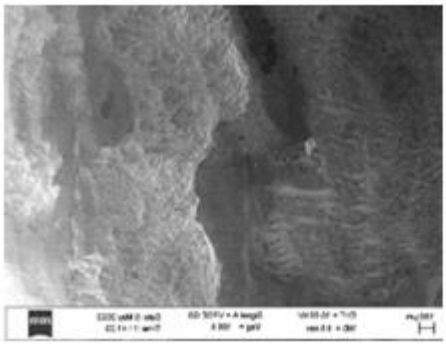

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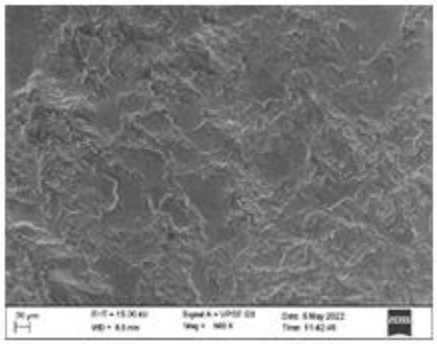

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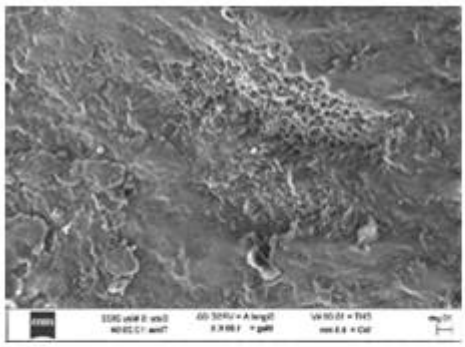

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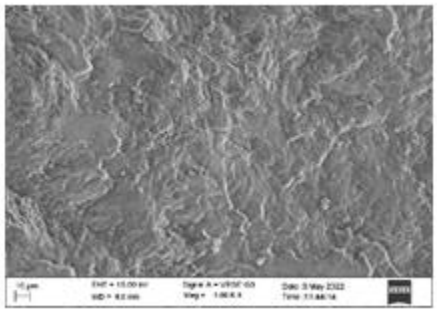

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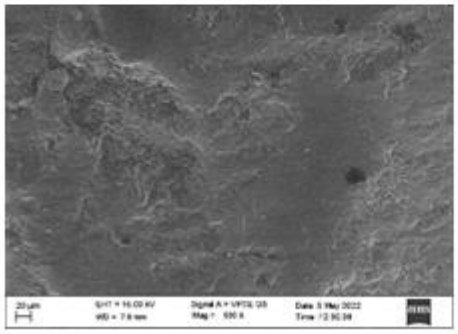

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GROUP III: Treated Using Root Debridement Tip "H3"

GROUP IV: Control Group

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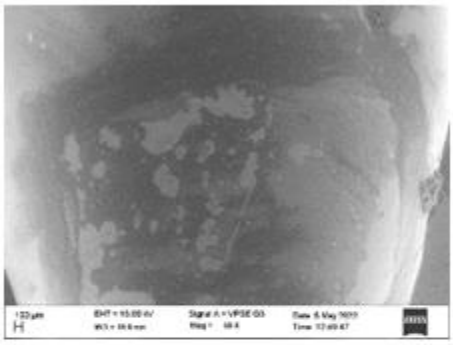

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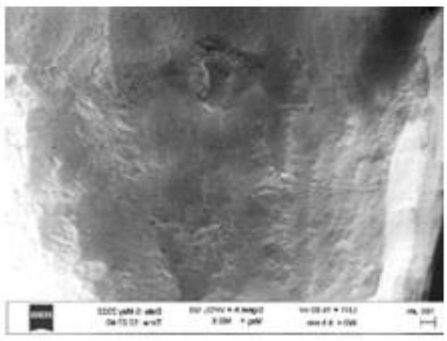

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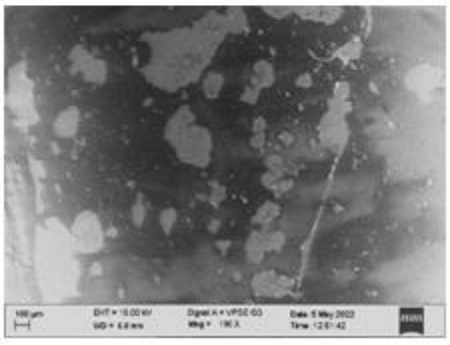

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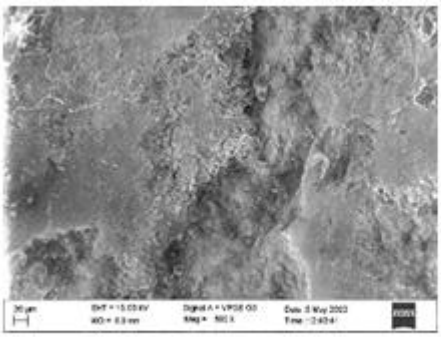

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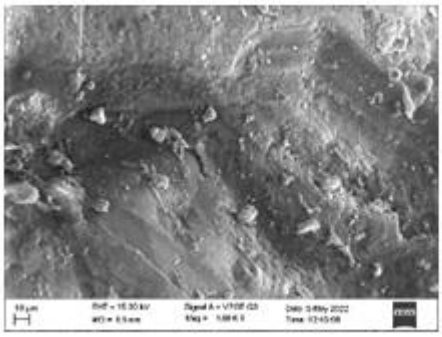

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Results

The roots treated with the hand curette had many linear injuries, which were thought to have been caused by the instrumentation. The roots treated with root debridement tip H3 had a clean smooth surface and showed less. Most specimens showed only slight loss of tooth substance, and most of the cementum was intact. The roots treated with ultrasonic tip no.1 showed relatively more roughness and loss of tooth substance. Evaluation of remaining calculus using RCI [Table 1] and loss of tooth substance using LTSI [Table 2] showed no significant differences between the three groups. Evaluation of root surface texture using RLTSI [Table 3]

Table 1: Showing Cross Tabulation On Remaining Calculus Index And Groups

	Group				Total
	Group 1	Group 2	Group 3	Group 4	
No calculus remaining on the root surface	0 0.0%	2 18.2%	4 36.4%	4 36.4%	10 22.7%
Small patches of extraneous material, probably consisting of calculus	6 54.5%	9 81.8%	7 63.6%	7 63.6%	29 65.9%
Definite patches of calculus confined to relatively small areas	5 45.5%	0 0.0%	0 0.0%	0 0.0%	5 11.4%
Total	11 100.0%	11 100.0%	11 100.0%	11 100.0%	44 100.0 %

Table 2: Showing Cross Tabulation In Loss Of Tooth Substance Index And Group

	Group				Total
	Grou p 1	Group 2	Group 3	Grou p 4	
No detectable loss of tooth substance	1 9.1%	0 0.0%	4 36.4%	11 100.0 %	16 36.4%
Slight loss of tooth substance restricted to localized areas; most of the cementum intact	5 45.5%	4 36.4 %	7 63.6%	0 0.0%	16 36.4%
Definite loss of tooth substance on most of the treated surface, but without deep instrumental marks in the dentin; cementum may be absent in some areas	5 45.5%	7 63.6 %	0 0.0%	0 0.0%	12 27.3%
Total	11 100.0 %	11 100.0 %	11 100.0 %	11 100.0 %	44 100.0 %

Table 3: Showing Cross Tabulation Of Roughness Loss Of Tooth Substance Index And Group

	Group				Total
	Group 1	Group 2	Group 3	Group 4	
Smooth or even root surface, without marks from the instrumentation and with no loss of tooth substance	2 18.2%	0 0.0%	5 45.5%	11 100.0%	18 40.9%
Slightly roughened or corrugated local areas confined to the cementum	5 45.5%	3 27.3%	6 54.5%	0 0.0%	14 31.8%
Considerable loss of tooth substance, with instrumentation marks extending into the dentin. The cementum is completely removed in large areas or there are a considerable number of lesions due to the instrumentation	4 36.4%	8 72.7%	0 0.0%	0 0.0%	12 27.3%
Total	11 100.0 %	11 100.0 %	11 100.0 %	11 100.0%	44 100.0 %

Discussion

Periodontitis is an inflammatory disease of the supporting tissues of the teeth caused by specific microorganisms or groups of specific microorganisms resulting in progressive destruction of the periodontal ligament and alveolar bone with pocket formation, recession, or both[4]. Timely and vigilant management of periodontal diseases are necessary to prevent the tooth loss due to irreversible bone destruction. The successful management is based on the bacterial plaque control and restriction of further progression of the disease[5]. Diverse bacteria exist in the subgingival plaque, forming an extremely complicated bacterial flora and leading to the formation of biofilm in the periodontal pocket which directly or indirectly causes damage to the periodontium by producing or inducing the production of various kinds of enzymes and exotoxins[6,7]. Therefore, the major focus of conventional periodontal therapy is mechanical debridement of bacterial plaque and bacterial products from the root surfaces and periodontal pockets[6].

Scaling and root planing is considered as the first line of treatment for the management of periodontal disease, which targets to prepare healthy and smooth root surface for the attachment of delicate healing gingival tissue[5]. Hand and ultrasonic scalers are common instruments used for the debridement of root surface as a part of periodontal therapy[8]. The type of instrument used for debridement can affect the surface texture and surface mechanical properties. Rough areas caused by instrumentation will influence the bacterial colonization and increase the rate of plaque formation[9]. Studies have shown that fibroblasts do not attach and develop on diseased root surfaces due to the presence of bacterial toxins[10]. Loss of tooth substance may cause exposure of the contents of dentinal tubules and lead to hypersensitive surfaces. Ideal instrument should therefore enable us to remove all extraneous substances from the root surfaces without any iatrogenic effects[9,11]. A detailed understanding of the different treatment modalities on the root surface topography may be considered important because it affects the attachment of bacteria and the outcomes of treatment.

Hand instruments and ultrasonic scaler are the instruments used for surgical and non-surgical periodontal therapy and have shown similar results as for biological response, plaque/calculus removal and elimination of endotoxin[12]. The adjustment in working parameter, and tips design has an impact on root surface roughness and on deposits removal. Working parameter including tip angulation, power setting, instrument contact time, tip design and lateral forces are relative to tooth damage. Tip design also make difference on tooth surface and deposits. Tip diameter of H3 is narrow compared to other available tips. Hence, produces a surface free of roughness. Limited data is available in the literature regarding the use of root debridement tip “H3” for performing SRP. Hence the present invitro study was undertaken to analyse and compare the root surface characteristics, after hand scaling and ultrasonic scaling. Root surface characteristics such as the amount of remaining calculus, loss of tooth substance, roughness loss of tooth substance was evaluated based on visual examination of SEM, and the scoring was done according to the defined criteria[13,9].

Present study showed that the amount of calculus deposits on the root surfaces after ultrasonic scaling were less compared to other groups, but the results were not statistically significant. These results were in accordance with the study done by **Antush Mittal (2014)[8]** which showed that the scaling and root planing performed with ultrasonic scaler tip “H3” had less residual calculus. Our study also showed statistically

significant decrease in the residual calculus after ultrasonic scaling compared with hand scaling. However, several studies have failed to reveal any differences between hand and ultrasonic instruments regarding efficiency of calculus removal (**Stende & Schaffer 1961[14]**, **Stewart et al. 1967[15]**, **Drisko (2001)[16]**). The discrepancy may be due to differences in experimental design such as the power of the ultrasonic scaler, the shape of the tip, exposed/non exposed root surfaces or in the assessment of the effects[4].

SEM observations in our study shows high statistically significant decrease in the loss of tooth substance after instrumentation performed with root debridement tip "H3" compared to hand curette and universal scaler tip no.1. This result was similar to results obtained by **Ribeiro et al (2006)[17]**, it was shown that diamond coated sonic tips and ultrasonic universal tips produced similar roughness of surface which was higher than that produced by hand curettes. Our findings corroborate with the study conducted by **Kiran suradkar (2018)[18]** and **Pawan Kumar (2015)[19]** regarding instrumentation with curettes and ultrasonic instruments, where ultrasonic universal scaler tip no 1 produced more roughness than hand instruments. Loss of tooth substance under clinical conditions not only depends on the mode of action and shape of the instrument used but also on tip design, angulations and application force exerted by individual operators[20]. These could be the factors which influence the outcome of our study.

SEM observations in our study shows high statistically significant decrease in the roughness loss of tooth substance after instrumentation performed with root debridement tip "H3" compared to hand curette and universal scaler tip no.1. This result was similar to results obtained by **Ribeiro et al (2006)[17]**, it was shown that diamond coated sonic tips and ultrasonic universal tips produced similar roughness of surface which was higher than that produced by hand curettes. Our findings corroborate with the study conducted by **Kiran suradkar (2018)[18]** and **Pawan Kumar (2015)[19]** regarding instrumentation with curettes and ultrasonic instruments, where ultrasonic universal scaler tip no 1 produced more roughness than hand instruments. Loss of tooth substance under clinical conditions not only depends on the mode of action and shape of the instrument used but also on tip design, angulations and application force exerted by individual operators[20]. These could be the factors which influence the outcome of our study.

The findings of this study uphold the fact that scaling and root planing with root debridement tip "H3" provides better removal of calculus, reduces roughness, loss of tooth substance. Within the limits of this study, it can be concluded that ultrasonic instrumentation with root debridement tip "H3" consistently produces the smoothest and even root surfaces with reduced loss of excess tooth substance when compared to ultrasonic instrumentation with universal tip no.1 and hand instrumentation with gracey curette. Ultrasonic instrumentation with universal tip can cause excess loss of tooth substance and roughness. As because, in this study, ultrasonic instrumentation with universal tip for root surface was not time bound in terms of fixed number of seconds, number of strokes of scalers. However, the topography of the root surface mineral content as produced by the periodontal disease process might have influenced the topographical view of the surface under SEM. This, has determined the difference in surface smoothness after instrumentation, there is a need for the comprehensive understanding of the

consequences that may occur on topography of root surface during instrumentation.

Limitations of the study

1. The number of strokes, time consumed and the pressure applied during hand instrumentation was different. This may affect the outcome of our findings.
2. Time required and number of strokes of ultrasonic scaler unit was not recorded.
3. The usage of magnification loupes would have enhanced better visibility which in-turn would have resulted in better outcomes.
4. The root debridement tip "H3" used in this study is fragile.

Conclusion

Mechanical debridement using hand instruments and ultrasonic scalers plays a vital role in the management of periodontal diseases. Smooth surface following mechanical debridement are of clinical significance to prevent bacterial plaque redepositing, calculus formation and also for better tissue healing. So, the efficiency of the scaling instrument to produce smooth surface is an important parameter.

In this present study, the usage of ultrasonic root debridement tip "H3" provided better removal of calculus, significant reduction in roughness and loss of tooth substance. It was observed from the present study that root debridement tip enhances the efficacy of supragingival and subgingival scaling and root planning removed less amount of tooth substance and roughness than ultrasonic universal tip no.1 and hand instrumentation but there was more residual calculus left in hand instrumentation and loss of tooth substance was comparatively higher in ultrasonic universal tip no.1. Ultrasonic instruments were easy to use, caused less operator fatigue.

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