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COMPARATIVE EVALUATION OF SIMULATED PLAQUE BIOFILM REMOVAL FROM A MODEL ROOT SURFACE FOLLOWING THREE DIFFERENT DEBRIDEMENT METHODS: AN IN-VITRO STUDY

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Abstract:

Aim: The aim of this study was to evaluate and compare the difference in the amount of removal of simulated biofilm from root surface following root surface debridement [RSD] using three different intervention modalities in an in-vitro model assessed by digital subtraction image analysis.

Methods and Material: An anatomical model of mesial aspect root of 36 was sprayed with articulation spray to simulate dental biofilm. This model was subjected to RSD using standard gracey's curette #15-16(Group A), ultrasonic root debridement with HC tip (Group B), and glycine powder air abrasion(Group C).The difference between pre and post debridement mean grey value depicting surface area of simulated biofilm removed from root surfaces assessed for probing depth zones from 0 up-to 3mm(zone 1), more than 3 up-to 6mm(zone 2) and more than 6mm(zone 3).

Statistical analysis: The data for all three groups demonstrated normal distribution which was checked using Shapiro-Wilk test.Inter group comparison (>2 groups) was done using one way ANOVA followed by pair wise comparison using post hoc test.

Results: Upon inter-group pair wise comparison group A demonstrated the most reduction in post debridement mean grey values as compared to group B and C in all three probing depth zones1,2 and 3 respectively(p-value = 0.00). Inter-group comparison between Group B and Group C demonstrated no significant difference in reduction in post debridement mean grey valuesin probing depth zone 1, 2 and 3. (p-value>0.05)

Conclusions: Debridement with curettes is most efficacious in RSD for all probing depths as compared to ultrasonic scaling and air abrasion.

Key-words: Root surface debridement, periodontal maintenance, image analysis

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Introduction:

Periodontitis is a plaque induced inflammatory disease leading to loss of attachment and alveolar bone loss around the affected teeth. Root debridement is a essential component of nonsurgical periodontal therapy involving the removal of dental plaque, calculus and altered cementum from affected root surfaces. During maintenance prevention of accumulation of plaque and its periodic removal during maintenance visits is essential for success of therapy. The proceedings of the first European Workshop on Periodontology defined "subgingival debridement was as the gentle mechanical subgingival instrumentation carried out to disrupt and/or remove the acquired biofilm" [1][2][3]. Root surface debridement [RSD] involves careful removal of deposits of plaque and calculus from the root surface. Manual instrumentation by curettes meant for subgingival debridement during maintenance phase have extended shanks to instrument root surfaces at probing depths of 5mm and beyond. Ultrasonic driven subgingival scaler tips meant for subgingival debridement are designed to instrument root surfaces at depths beyond 5mm with added benefit ofthe cavitation effect of the lavage water. Past literature reports that manual curettes and ultrasonic-driven subgingival scaler tips are equally efficacious in their ability to debride the root surfaces in periodontal pockets under 5 mm probing depths [4][5]. Recently, the use of air abrasion polishing system using glycine or erythritol powder have also been used during periodontal maintainence therapy for root surface debridement. There were limited studies which compared efficacy of hand curettes, ultrasonic driven and air abrasion polishing system in root debridement at different probing depths owing to limited methods to assess sub-gingival debridement clinically.Therefore, the aim of this study was to compare the efficacy of hand curettes, ultrasonic driven sub-gingival root debridement tip and glycine powder air abrasion polishing driven root surface debridement methods at different probing depths in an anatomically correct artificial root surface model in an in-vitro artificial model with simulated dental plaque biofilm by image subtraction analysis.

Materials and Methods:

This study was an single centric, prospective, experimental in-vitro study performed on an artificial model designed for sub-gingival root planing exercises replicating the anatomically correct root morphology (Fig 1) (Periodontology Practice Model, SKU: SP013, Navadha Enterprise, Mumbai). The mesial proximal surface of the right mandibular molar [36] was considered as the study root surface for this study. This study model had simulated horizontal bone loss between 35 and 36 with artificial soft clear silicon replicating the lateral pocket wall with the gingival margin coinciding with the mesial proximal cemento-enamel junction of 36 simulating a probing depth of 11 mm from the gingival margin to the alveolar crest.The dental plaque biofilm was simulated by an green colored aerosol universal color indicator (Fig 2) (Arti-Spray, Bausch, Germany)that left a colored film simulating the dental biofilm on the opalescent root surface of the study tooth.[6]

The study tooth was dearticulated for application of simulated biofilm spray and pre-

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intervention image record. Images were recorded using a camera having a 100-mm Macro-Zoom lens [Canon EOS D30, Tokyo, Japan] fixed to a tripod under the settings of Manual exposure mode [ISO 1/100, Manual Focus, shutter speed 1/200secs], with flash white balance and auto-lightening optimizer deactivated at distance of 1.5meters in a reproducible position. After taking pre-intervention images, the study tooth was re-articulated and was subjected to either of the three root surface debridement intervention under study. A total number of serial 25 runs of each intervention (n=25) were performed with each run preceded with a freshly sprayed simulated biofilm on the study root surface. The interventions were performed by a single trained operator under the following settings:
Group A: Root surface debridement with Gracey curette (Fig 3):
An area specific Gracey's Curette #15/16 [SGR15/164 Hu-friedy, Chicago,IL] activated from apical to coronal direction with 15-20 root planing strokes with a modified pen grasp and conventional finger rest.
Group B: Root surface debridement with ultrasonic driven root debridement tip (Fig 4): A piezoelectric ultrasonic driven root debridement tip [HC tip, Acteon Group, France] with linear oscillations at 30Khz and with power set to 10 and maximum lavage water output [P5 Booster SUPPRON SatelecActeon] using apical to coronal motion for the duration of 15 seconds.
Group C: Root surface debridement with air abrasion polishing with glycine powder (Fig 5): Air Polishing with Glycine abrasive powder (EMS AirFLOWHandy 2+ using AirFLOW PERIOpowder 25µm mean particle size) with water settings standardized to 50 % of the maximum level.
Post intervention the study tooth was de-articulated for post intervention images, taking care not to disturb the root surface. The post intervention images were also taken by identical specified settings as in pre-intervention images. The pre-intervention and post-intervention images of the study root surface were processed by image processing software [Image J, National Institute of Health, USA] for mean grey values for each probing depth zone. The probing depth zones measured beginning from the gingival margin on the mesial surface of mesial root 36 were divided into the following probing depth zones at upto 3mm(zone 1), more than 3mm and up to 6mm (zone 2) and greater than 6mm (zone 3) respectively by superimposing a grid on the pre and post intervention images. The mean grey values of each zone depicted the surface cover of the simulated biofilm which is a sum of the grey values of all the pixels in the selection divided by the number of pixels in each zone of the image [average of the x and y coordinates of all of the pixels in the image].[7] Therefore theamount of simulated biofilm removed from the tooth root surface post debridement was derived by calculating the difference in mean grey values of the respective probing depth zones between pre and post intervention image analysis. Pre and post intervention images given in fig.6

The difference in pre and post intervention mean grey values therefore depicted the efficacy of simulated plaque removal by different debridement methods under study.All pre and post intervention mean grey value data for each sample per intervention were entered into a computer using MS Office Excel Sheet software (v 2019, Microsoft Redmond Campus,

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Redmond, Washington, United States) and subjected to statistical analysis using Statistical package for social sciences (SPSS v 26.0, IBM).

Results:

The pre and post intervention mean grey values for all intervention groups [n=25 each] were provided in spread sheet to the statistician. The differences between the pre and post intervention values were expressed as mean and standard deviation for all groups A, B and C. The data demonstrated normal distribution by Shapiro-Wilk test therefore parametric tests were used for inter-group comparisons using one way ANOVA (>2 groups)followed by pair wise comparison using post hoc test. P value of less than 0.05 was considered to be statistically significant with β error at 20%, rendering the study a power of 80%.

Inter-group comparison for difference in pre and post debridement mean grey values between all three groups was performed using one way ANOVA [table 1]. Reduction in pre and post intervention mean grey values were compared for total reduction in mean grey values for total root surface [236.77 ± 32.66, 171.88 ± 11.17, 164.08 ± 16.35] p=0.00] ; zone 1 [148.49 ± 18.01, 114.10 ± 18.01, 108.64 ± 3.71] p=0.00; zone 2 [83.20 ± 27.16, 55.63 ± 14.43, 50.36 ± 15.09] p=0.00 ; and zone 3 [10.06 ± 2.55, 7.78 ± 4.83, 5.08 ± 2.47] p=0.00 between group A, group B, and group C respectively. Therefore post-hoc test was used to evaluate the exact level of statistical significance for inter-group pair-wise comparison between the 3 groups in total root surface removal and also within zone 1, zone 2 and zone 3 respectively [Table 2] .

For removal of simulated biofilm in total root surface area, group A demonstrated significant mean gray value reduction in comparison to group B [114.88 ± 6.23 , p=0.00] and group C [72.68 ± 6.23, p=0.00] .In comparison between group B and group C, group B demonstrated significant reduction [42.19 ± 6.23 ,p=0.00].

Within zone 1, group A demonstrated significant mean gray value reduction as compared to group B [34.38 ± 3.43, p=0.00] and group C [39.84 ± 3.43, p=0.00]. There was no significant difference in mean gray value reduction between group B and group C [5.49 ± 3.43, p=0.25].

Within zone 2, group A demonstrated significant mean grey value reduction as compared to group B [27.57 ± 5.59, p=0.00] and group C [32.84 ± 5.59, p=0.00] respectively. There was no significant difference in mean grey value reduction between group B and group C [5.27 ± 5.59, p=0.61].

Within zone 3, Group A demonstrated statistically significant reduction in mean gray values as compared to group C [4.98 ± 0.98, p=0.000] , however there was no significant difference in mean grey value reduction between either group A and group B [2.27 ± 0.98, p=0.05] or between group B and group C [2.70 ± 0.980, p=0.02].

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Discussion:

The current study was performed to compare three root surface debridement intervention in an in-vitro model for evaluating plaque removal depicted by difference in pre and post debridement mean grey values for total root surface area and within probing depth zones of 0-3mm, 3-6mm and greater than 6mm by digital subtraction image analysis.

The results of the present study showed that intervention group performing root surface debridement with hand curettes [236.77 ±32.66] demonstrated most reduction in mean grey values as compared to ultrasonic tips [171.88 ± 11.17] and air abrasion with glycine powder [164.08 ± 16.35]for total root surface area [p=0.00]. For the probing depth zone of up to 3mm, root surface debridement by hand curette demonstrated most reduction in mean grey values [148.49 ± 18.010] as compared to ultrasonic tips [114.10 ± 10.24] and by air abrasion with glycine powder[108.64 ± 3.71] [p=0.00] . For probing depth zone of more than 3mm less than 6mm, root surface debridement by hand curette demonstrated most reduction in mean grey values [83.20 ± 27.16] followed by ultrasonic tips [55.63 ± 14.43] and air abrasion with glycine powder[50.36 ± 15.09] [p=0.00]. For the probing depth zone of more than 6mm, root surface debridement by hand curette demonstrated most reduction in mean grey values [10.06 ± 2.55] as compared to ultrasonic tips [7.78 ± 4.83] and air abrasion with glycine powder [5.08 ± 2.47] .

Upon pairwise comparison of difference in post intervention mean gray values for total root surface area, debridement using hand curettes demonstrated most difference as compared to ultrasonic tip debridement [114.88 ± 6.23, p=0.00] and debridement by air abrasion using glycine powder [72.68 ± 6.23, p=0.00] .

These results were in agreement with the findings of Ramfjord, S.P(1987)[8], Hämmerle, C.H.F.(1991)[9] in their clinical studies who stated that manual debridement by curettes was more effective as compared to ultrasonic debridement during scaling and root planing procedures. This was also supported by the observations of Brayer in 1989[10] who found that manual driven curettes by virtue of increased tactile sensitivity and dexterity of an experienced operator resulted in maximum removal of root surface biofilm as compared to ultrasonic debridement. However to the contrary, Zafar et 2016[11] found that ultrasonic scalers were equally capable in performing debridement as compared to gracey curettes with no significant difference demonstrated between them at various probing depths.

Upon pairwise comparison of difference in post intervention mean gray values for probing depth zone of up to 3mm, debridement using hand curettes demonstrated most difference compared to ultrasonic tip debridement [34.38 ± 3.43, p=0.00] and debridement by air abrasion using glycine powder[39.84 ± 3.43, p=0.00]. However, root surface debridement by ultrasonic tip and air abrasion by glycine powder showed comparable results [5.45 ± 3.43, p=0.25]. This finding was in agreement with the observations of Lu H(2018)[5](2019)[12] who found that at probing depths of less than 4 mm air abrasion polishing demonstrated similar plaque removal efficacy as compared to ultrasonic debridement.

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Upon pairwise comparison of difference in post intervention mean gray values for probing depth zone of more than 3mm and less than 6mm, debridement using hand curettes demonstrated most difference compared to ultrasonic tip debridement [27.57 $\pm$ 5.59, p=0.00] and debridement by air abrasion using glycine powder[32.84 $\pm$ 5.59, p=0.00]. However, root surface debridement by ultrasonic tip and air abrasion by glycine powder showed comparable results [5.27 $\pm$ 5.59, p=0.61]. These results were in agreement with Wennstrom et (2011)[13] and Müller N et al (2014)[14]who compared ultrasonic instrumentation and air abrasion polishing system using erythritol powder and concluded that no pertinent differences in clinical outcomes between subgingival air polishing and ultrasonic debridement of moderate deep pockets of 4 to 5mm in supportive periodontal therapy patients.

However, in probing depth zone of more than 6mm, root surface debridement using curette compared with ultrasonic tip showed comparable results [2.27 $\pm$ 0.98, p=0.05] but demonstrated greater significant difference as compared to air abrasion with glycine powder [4.98 $\pm$ 0.98, p=0.00], this finding can be attributed to accessibility of the debridement instrument at deeper probing depths as also found in the observations of Rabanni (1981)[15] who concluded that as the pocket gets deeper, the apical part of the pocket is narrower making accessibility for the instrument to the base of the pocket difficult.

Therefore from the findings of this study it may be permissible to infer that root surface debridement by hand curettes showed maximum efficacy in plaque removal for the total root surface area and for probing depth zones of up-to 3mm and 3-6mm as compared to ultrasonic tip and air abrasion using glycine powder. However, in probing depth zone of more than 6mm, hand curettes demonstrated comparable efficacy in plaque removal as ultrasonic driven tip. Root surface debridement by ultrasonic tip as compared to air abrasion by glycine powder showed comparable removal of plaque biofilm with probing depth zones of 0-3mm, 3-6mm and more than 6mm.

Limitations:

As this study was an in-vitro study with simulated biofilm, the tenacity of plaque biofilms and their relative thickness within gingival sulcii were difficult to replicate. The changes in root surface characteristics post debridement were beyond the scope of the study. Although best efforts were made to standardize debridement methods, the operator bias cannot be entirely ruled out.

Conclusion:

Under the present study settings, it may be permissible to conclude that, debridement by hand curettes demonstrated the most efficacy in root surface debridement at all probing depths from up to 3mm, 3-6mm, and greater than 6mm. Whereas ultrasonic RSD and Air abrasion polishing with glycine powder were equally efficacious in root surface debridement in probing depths of under 6 mm.

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Reference:

1. Waerhaug J. Healing of the dento-epithelial junction following subgingival plaque control. I. As observed in human biopsy material. *J Periodontol*. 1978;49:1-8.

2. Badersten A, Nilvéus R, Egelberg J. Effect of nonsurgical periodontal therapy. I. Moderately advanced periodontitis. J Clin Periodontol. 1981;8:57-72.

3. Lindhe J, Westfelt E, Nyman S, Socransky SS, Haffajee AD. Long-term effect of surgical/non-surgical treatment of periodontal disease. J Clin Periodontol. 1984;11:448-58.

4. Hägi TT, Hofmänner P, Salvi GE, Ramseier CA, Sculean A. Clinical outcomes following subgingival application of a novel erythritol powder by means of air polishing in supportive periodontal therapy: a randomized, controlled clinical study. Quintessence Int. 2013;44:753-61.

5. Lu H, He L, Zhao Y, Meng H. The effect of supragingival glycine air polishing on periodontitis during maintenance therapy: a randomized controlled trial. PeerJ. 2018;6:43-71.

6. Tuna, T, Kuhlmann, L, Bishti, S, Sirazitdinova, E, Deserno, T, Wolfart, S. Removal of simulated biofilm at different implant crown designs with interproximal oral hygiene aids: An in vitro study. Clin Oral Impl Res.2019;30:627-36

7. U.S. Department of Health and Human Services. (n.d.). *Analyze menu*. National Institutes of Health. Retrieved February 3, 2022, from https://imagej.nih.gov/ij/docs/menus/analyze.html

8. Ramfjord SP, Caffesse RG, Morrison EC, et al. 4 modalities of periodontal treatment compared over 5 years. J Clin Periodontol1987;14:445-52.

9. Hämmerle CH, Joss A, Lang NP. Short-term effects of initial periodontal therapy (hygienic phase). J Clin Periodontol.1991;18:233-39.

10. Brayer WK, Mellonig JT, Dunlap RM, Marinak KW, Carson RE. Scaling and root planing effectiveness: the effect of root surface access and operator experience. J Periodontol.1989;60:67-72

11. Zafar MS. Comparing the effects of manual and ultrasonic instrumentation on root surface mechanical properties. Eur J Dent.2016;10:517-21.

12. Lu H, Zhao Y, Feng X, He L, Meng H. Microbiome in maintained periodontitis and its shift over a single maintenance interval of 3 months. J Clin Periodontol. 2019;46:1094-104.

13. Wennström JL, Dahlén G, Ramberg P. Subgingival debridement of periodontal pockets by air polishing in comparison with ultrasonic instrumentation during maintenance therapy. *J Clin Periodontol*. 2011;38:820-27.

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Volume 06 Issue 2
2024

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http://magellanes.com/

14. Müller N, Moëne R, Cancela JA, Mombelli A. Subgingival air-polishing with erythritol during periodontal maintenance: randomized clinical trial of twelve months. J Clin Periodontol.2014;4:883-9.

15. Rabbani GM, Ash MM Jr, Caffesse RG. The effectiveness of subgingival scaling and root planing in calculus removal. J Periodontol. 1981;52:119-123.

16.

Table No 1: Intergroup Comparison Between Groups For Difference In Mean Grey Values Pre And Post Debridement Using Anova

Reduction in post debridement (mean grey values)	Group	N	Mean	Std. Deviation	Std. Error	p value of one way ANOVA
Total root surface area	A	25	236.771560	32.6602552	6.5320510	0.000*
	B	25	171.887600	11.1776493	2.2355299	
	C	25	164.084240	16.3577257	3.2715451	
Probing depth zone 1	A	25	148.49	18.010	3.602	0.000*
	B	25	114.10	10.247	2.049	
	C	25	108.64	3.714	0.743	
Probing depth zone 2	A	25	83.20	27.168	5.434	0.000*
	B	25	55.63	14.435	2.887	
	C	25	50.36	15.099	3.020	
Probing depth zone 3	A	25	10.06	2.559	0.512	0.000*
	B	25	7.78	4.833	0.967	
	C	25	5.08	2.476	0.495	

(where p>0.005) (ANOVA- Analysis of variance, zone 1= 0-3mm, zone2= 3-6mm, zone 3= more than 6mm)

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Table 2: Pair-Wise Comparison Of Pre And Post Debridement Mean Grey Value Between Groups A, B And C For Zone 1, Zone 2, Zone 3

Difference in reduction post debridement	group	group	Mean Difference	Std. Error	p value
Difference in total root surface area	A	B	114.883*	6.237	0.000*
		C	72.687*	6.237	0.000*
	B	C	42.196*	6.237	0.000*
Probing depth zone1(0-3mm)	A	B	34.386*	3.438	0.000*
		C	39.845*	3.438	0.000*
	B	C	5.459	3.438	0.257
Probing depth zone2 (3-6mm)	A	B	27.571*	5.596	0.000*
		C	32.842*	5.596	0.000*
	B	C	5.272	5.596	0.616
Probing depth zone3(more than 6m m)	A	B	2.275	0.980	0.059
		C	4.981*	0.980	0.000*
	B	C	2.706*	.980	0.020

(where $p<0.005$) (zone 1= 0-3mm, zone 2= 3-6mm and zone 3= more than 6mm)

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Images:

Figure 1: Anatomical root model

Figure 2: Articulating spray for simulating biofilm

Figure 3: Gracey curette #15-16

Figure 4: Ultrasonic handpiece with root debridement insert

Figure 5: Air abrasion polishing hand piece with glycine powder

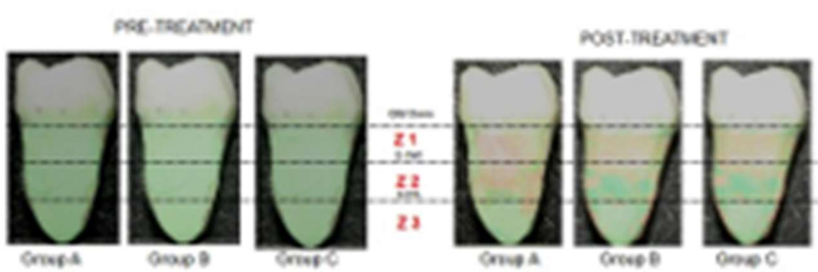

Figure 6: Pre and Post debridement image