Comparative Evaluation of Root Surface Changes by Air-Polishing using Glycine and Chlorhexidine Acetate Powder: An in-vitro Study

Dr. Hardi Rajanbhai Shukla,[1] Dr. Aditi Mathur,[2] Dr. Neema Shetty,[3]
Dr. Barkha Makhijani,[4] Dr. Balaji Manohar[5]

[1]Resident, [2,3]Reader, [4]Senior Lecturer, [5]Professor and Head
Department of Periodontics, Pacific Dental College and Hospital, Udaipur, India

ABSTRACT

Background: Biofilm removal is the central part of the etiotropic and maintenance phase of periodontal therapy. Commercially available injection water jets such as Prophy-Jet allows an efficient and convenient biofilm removal as an adjunct to mechanical periodontal therapy. But, due to the abrasive nature of traditionally used air polishing powders such as sodium bicarbonate, there is a continuous research going on for less abrasive materials.

Aims: To compare the effectiveness of air polishing using glycine powder and chlorhexidine acetate powder on tooth surface as compared to ultrasonic scaling and also to evaluate the time taken for stain removal.

Materials and Methods: Thirty fully erupted, single rooted teeth extracted due to poor periodontal prognosis were used in this in-vitro study. The sample teeth were divided into 3 equal groups and stained in coffee solution. The test Groups A and B underwent air-polishing with glycine powder and chlorhexidine acetate powder respectively. Group C was control group and underwent ultrasonic scaling. Time taken for stain removal was recorded. The sample teeth were also evaluated under a stereo-microscope and digital micrometer pre-procedurally and post-procedurally to measure surface changes.

Results: The study showed statistically significant results ($p<0.05$) when measurements of changes in surface roughness of samples treated with glycine powder air-polishing were compared with ultrasonic scaling and chlorhexidine acetate powder air-polishing were compared with ultrasonic scaling. Surface texture loss as well as time taken for stain removal was minimum with glycine powder and maximum with ultrasonic scaling.

Conclusion: Air-polishing with glycine powder was least abrasive on root surface followed by chlorhexidine acetate powder air-polishing. This is because of the lower particle size of glycine which also covers larger area in lesser time.

Key Words: Chlorhexidine acetate, glycine, maintenance therapy, Prophy-Jet, sodium bicarbonate, stereo-microscope

INTRODUCTION

Periodontitis is a chronic bacterial infection and its treatment necessitates thorough removal of the bacterial biofilm during the initial and the maintenance phase. Maintenance phase plays an important role in preventing loss of attachment with an optimal time interval of 3 months between two visits.[1] One of the goals in the maintenance visit is plaque removal and smoothening of root surface. This has been achieved by: rubber cup polishing, hand scaling, ultrasonic scaling and more recently by air-powder abrasive system.[2] However, debridement using hand instruments or oscillating scalers is both technically demanding and time consuming.[3-5] Also, safety, as well as ease of biofilm removal, are of major importance because the demand for periodontal therapy is increasing and the number of well-trained dental personnel is limited.[6-8] For optimal treatment of periodontal disease, instrumentation techniques should be employed that can be safely used by the dentist, hygienist or auxiliary dental staff. The uses of commercially available injection abrasive water jets, also known as air-polishing devices, are highly efficient and convenient for biofilm removal.[9]

The use of air powder abrasive system, the Prophy-Jet,[10] may be an alternative for hand instrumentation for the removal of plaque and diseased cementum.

Mode of stain removal in air polishing system is by the

Correspondence:
Dr. Hardi Rajanbhai Shukla
Department of Periodontics, Pacific Dental College and Hospital, Udaipur, India
email: hrshukla08@gmail.com

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interaction of solid particles with the surface to be treated. This is the basic event in abrasive processes caused by water jets.[11-13]

Since the 1980s, sodium bicarbonate has been used in air-polishing devices and is considered to be an ideal abrasive medium for intra-oral use because it is nontoxic and water soluble. However, the mean particle size of sodium bicarbonate is very large (250 µm). Sodium bicarbonate air-polishing also leads to substantial erosion or dulling effects of filling materials, such as amalgam, gold or composite, as well as glass ionomer and zinc-phosphate.[14-16]

Hard and soft tissue trauma, resulting from sodium bicarbonate air-polishing application compromises its routine use. Studies have shown that it is not possible to adjust the working parameters of air-polishing devices.[17,18] However; it may be possible to control and optimize the efficacy of air-polishing powders with mechanical properties differing from those of the commonly used sodium bicarbonate powder.

Glycine is a non-essential amino acid and is an important component of most polypeptides. It acts as a neurotransmitter in the nervous system and also has many anti-inflammatory actions. The commercially available glycine powder (Figure 1) used in the air-polishing devices is produced by milling glycine crystals in an agate disc grinder. The particle size of 60 µm is obtained making the particle size approximately four times smaller than that of conventional sodium bicarbonate powder and is a low-abrasive.[17]

Chlorhexidine acetate powder (Figure 2) is mostly used in plastic surgeries in treatment of burns and for skin preparation before surgeries. Chlorhexidine acetate powder is partially soluble in water and has a wide range of anti-microbial properties and is effective against both gram positive and gram negative bacteria. Its anti plaque effect was assessed in a study where chlorhexidine acetate containing chewing gums with and without hydrogen peroxide coating were given to subjects and the results concluded good plaque control in both groups during 4 day test period.[19]

The aims of the present study were to evaluate the root surface changes by air-polishing using glycine powder, chlorhexidine acetate powder & by ultrasonic scaling and to compare the time taken to remove stain from the tooth surface using glycine powder, chlorhexidine acetate powder by air-polishing and by ultrasonic scaling.

MATERIALS AND METHODS

Thirty fully erupted, single rooted teeth, extracted due to poor periodontal prognosis and free from caries and fracture were selected for the study. The samples were divided into three equal groups. Group A (n=10) and Group B (n=10) served as test groups treated with air-polishing using glycine and chlorhexidine acetate powder respectively. While, Group C (n=10) was control group treated with conventional ultrasonic scaling. All the samples underwent ultrasonic scaling. After scaling, the measurements of all the sample teeth were recorded using a digital micrometer (Figure 3) and stereo-microscope (Figure 4) to determine their surface roughness prior to being subjected to air-polishing. Digital micrometer is a highly sensitive instrument capable of measuring surface changes ranging from 0.001 mm to 5 cm.

Each sample tooth was measured at two constant points i.e. at the cemento-enamel junction (CEJ) and at the mid-point between the CEJ and apical 1/3rd of the root. The mean of the values obtained at the CEJ and at the mid-point of the tooth was designated as the value of that particular sample.

All the teeth were stained in a solution of 10 mg coffee powder dissolved in 150 ml of distilled water for 60 minutes.[2] This staining was similar to the staining commonly encountered

Figure 1: Glycine Powder

Figure 2: Chlorhexidine acetate powder

Figure 3: Digital Micrometer

Figure 4: Stereomicroscope

Figure 5a: Extracted teeth specimen

Figure 5b: Teeth stained in coffee solution

Figure 6a: Prophy-Jet air abrasive system

Figure 6b: Air-polishing of extracted teeth

Figure 7a: Root surface under stereomicrosope pre-procedural

Figure 7b: Root surface under stereomicrosope post-procedural

during maintenance therapy (Figure 5a and 5b). The powder chamber of the Prophy-Jet was filled with the air-polishing powder (glycine or chlorhexidine acetate) and air-polishing was carried out. The Prophy-Jet was connected to 70 psi of compressed air and water supply of 50 psi and was directed towards the sample at 45 degrees in a sweeping motion.[2] (Figure 6a and 6b)

The time taken for stain removal as observed by the naked eye for each sample was recorded and the samples were then rinsed with water to eliminate the debris accumulated over the surface during air polishing. Samples were then again evaluated under the digital micrometer to measure the surface roughness on the sample at the two constant points. The specimen teeth were also observed under the stereo-microscope to evaluate the surface changes or variations (Figure 7a, 7b).

STATISTICAL ANALYSIS

Statistical analysis was done using ANOVA (Analysis of Variance) and post hoc test with p-value less than 0.05 applied with IBM SPSS software version 20.0.

RESULTS

The surface roughness was evaluated for all the samples. The mean of all the values of the samples from Group A, B and C before and after air-polishing were observed under a digital micrometer. The average pre-procedural surface roughness before air-polishing in Group A was 0.1896 ± 0.1713 mm, Group B was 0.2010 ± 0.4337 mm and Group C was 0.1817 ± 0.01442 mm. The surface roughness values after air-polishing for Group A, Group B and Group C were 0.2922 ± 0.3692mm, 0.3232 ± 0.9881 mm and 0.3870 ± 0.5226 mm respectively. The highest amount of surface texture loss was observed in Group C. The difference in measurements of Group C was 0.2053 mm. The difference in measurements of Group B was 0.1222 mm. The least amount of surface texture loss took place in Group A where the difference between the pre-procedural and post-procedural measurement values was only 0.1026 mm. (Table I)

The average time taken for stain removal from the sample surface was also measured. The time taken to remove stains with ultrasonic scaling was longest for Group C (31.9 seconds) followed by Group B (9.8 seconds) whereas; the time taken for stain removal by Group A was the least with 6.9 seconds. (Table I)

The inter-group comparison between the three groups for the loss in surface texture after air-polishing/ultrasonic scaling was evaluated. The comparison of mean values of surface roughness of Group A with Group B was statistically non significant (p = 0.317). When the mean values of surface roughness of Group A was compared to Group C, a

Table I: Surface roughness measurements and average time for procedure

	Group A		Group B		Group C	
	Mean	S.D	Mean	S.D	Mean	S.D
Pre-procedure	0.1896 mm	± 0.1713	0.2010 mm	± 0.4337	0.1817 mm	± 0.0144
Post-procedure	0.2922 mm	±0.3692	0.3232 mm	± 0.9881	0.3870 mm	± 0.5226
Difference	0.1026 mm		0.1222 mm		0.2053 mm	
Average Time	6.9 sec		9.8 sec		31.9 sec	

Table II: Comparison of surface roughness (p<0.05)

Group A		Mean Difference	Standard Error	Significant Values
Group A (0.2922)	Group B (0.3232)	-.03100	0.03039	0.317 (N.S.)
	Group C (0.3870)	-.09480*	0.03039	0.004 (S)
Group B (0.3232)	Group A (0.2922)	0.03100	0.03039	0.317 (N.S.)
	Group C (0.3870)	-.06380*	0.03039	0.045 (S)
Group C (0.3870)	Group A (0.2922)	0.09480*	0.03039	0.004 (S)
	Group B (0.3232)	0.06380*	0.03039	0.045 (S)

statistically significant difference (p = 0.004) was observed. A statistically significant difference (p = 0.045) was observed in the mean values between Group B and Group C. (Table II)

Stereo microscopic analysis showed a polished, smoother root surface as compared to the non-treated surface for all the three groups. No significant craters or depressions were visible.

DISCUSSION

The objective of this study was to evaluate the surface changes that took place on the sample tooth root surface during air polishing with glycine, chlorhexidine acetate and ultrasonic scaling. This study demonstrates that the air powder abrasive system removes stains from the root surface causing lesser abrasive changes as compared to ultrasonic scaling. Also, the average time taken to remove stains is reduced. Inter-group comparison of the root structure loss was least with glycine and most with ultrasonic scaling.

These findings were in agreement with Petersilka et al. 2003[17,20] and Flemmig et al.[21] who have demonstrated the efficiency and safety of glycine powder in sub-gingival air polishing. The chipping action of a scaler tip may alter the root surface as depicted by Vastardis et al.[22] which was evident in the present study as well. Also, a possible reason for more surface loss with ultrasonic scaling can be the tangential relationship of the blade with the root surface leading to more stroke application resulting in more root surface loss.

There is no printed literature available about the utility of chlorhexidine acetate powder as an air polishing agent. However, in a study by Ainamo et al.,[19] the anti-plaque effect of chlorhexidine acetate in chewing gums, with and without hydrogen peroxide releasing agent was assessed which showed that the chlorhexidine acetate containing chewing gums inhibited plaque growth and plaque weight. In the present study as well, the plaque and stain removing capacity of chlorhexidine acetate powder was at par with that of glycine powder. Apart from a slightly bitter taste and faint upper respiratory tract irritation, it was found to be efficient in its role as an air polishing powder.

The size as well as the shape of sodium bicarbonate crystals have caused severe gingival erosion as noted in previous studies. The lesser surface loss with glycine powder is attributed to its smaller particle size as compared to routinely used sodium bicarbonate which has more abrasive action due to larger particle size.[12,23,24]

Subgingival plaque and stain removal with ultrasonic scaler leads to more tooth surface loss as well as longer duration of treatment time. These findings are in accordance with previously published data which indicate that the subgingival insertion of a curette will inevitably lead to both damage and removal of some gingival epithelium and junctional epithelium.[25-27]

CONCLUSION

The average amount of root surface loss by air-polishing using glycine powder was the lowest followed by chlorhexidine powder. Ultrasonic scaling caused the maximum amount of root surface loss. Statistically significant results were obtained when air–polishing using glycine powder was compared with ultrasonic scaling and air-polishing using chlorhexidine powder was compared with ultrasonic scaling. Glycine proved to be the most effective air polishing agent in this study since it had the least abrasive effect on the root surface of the sample and also removed the stains faster. It was also evident that air powder abrasive system was more effective in stain removal as it covers a broader area over a shorter period of time and removes the same amount of stain when compared to ultrasonic scaling.

Also, with regards to chlorhexidine acetate powder and its use as an air polishing agent, further clinical trials are required to establish its effect and substantivity. It should be noted that mechanical stain removal is a result of an abrasive action on the surface resulting in more or less pronounced loss of surface texture depending on the material and method of cleaning used and hence should be used cautiously.

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