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Original Research Paper

Periodontics

COMPARATIVE ANALYSIS OF SURFACE ROUGHNESS OF TEETH AFTER AIR-POLISHING WITH DIFFERENT POWDERS AT DIFFERENT TIME INTERVALS-AN IN VITRO STUDY

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ABSTRACT

Background: Various polishing powders are available for the removal of dental plaque and stains, which may cause surface alterations to the sound enamel surface. **AIMS:** This in-vitro study aims to evaluate the surface roughness of the enamel surface caused by air polishing with Sodium Bicarbonate and Glycine at different settings of time using Prophy-jet. Settings and design: In 2 main groups, each having 2 subgroups including 20 tooth samples each, air polishing with both the powders was done for 15 sec and 30 seconds respectively in a sweeping motion at a fixed inlet pressure and distance of the nozzle. **Methods and Material:** In-vitro testing was performed on smooth human enamel surfaces of 80 extracted and preserved teeth. The surface roughness of each sample in a specified area was analyzed before and after air polishing (Prophy-jet) with the surface profilometer and SEM photographs were obtained and graded according to predefined criteria. Statistical Analysis used: Mean, Standard deviation, Chi-square test, paired-t test and unpaired-t-test. **Results:** The Ra was increased after air polishing with both agents. However, a statistically significant difference was observed when using sodium bicarbonate at both time intervals. SEM scores showed statistically significant differences in the surface topography when the time interval is 30 seconds. Glycine showed minimal surface roughness changes. **Conclusion:** Slight loss of enamel surface may occur using Sodium bicarbonate, and, when air-polishing time is increased from 15 sec to 30 sec.

KEYWORDS : Sodium bicarbonate, Glycine, Air-polishing, Surface roughness, SEM

INTRODUCTION

Periodontitis is a multifactorial disease[1], with the main etiologic factor being dental plaque. The aim of periodontal therapy not only includes the eradication of these pathogens but also, provides an environment conducive to accumulate no or minimum dental plaque. Many methods are used to achieve this purpose, one being polishing of the tooth surface.

Polishing is defined as "the implementation of making the tooth surface smooth and lustrous" (ADHA proceedings, 1997)[2]. Enamel and cementum appear to be smooth with the naked eye after instrumentation (Scaling and root planning). However, they develop surface irregularities and significantly affect microbial colonization, especially in the subgingival areas. Minimum surface roughness of the enamel will accumulate the least microbes, which can be achieved with the help of polishing.

Although polishing can be performed with both manual and engine-driven devices, with time, Air powder polishing devices have overcome the conventional rubber cup polishing methods with the advantages of being time-efficient, operator and patient-friendly, and effective in removing plaque, biofilm, and stains from the deep inaccessible areas to the rotary devices.

There's always been a dilemma about using the type of powder to make air polishing more effective and for how much time the tooth polishing should be done so that it can be most efficient and least hazardous to the enamel surface. The literature presented focuses more on the effects of air polishing on restorative materials and cementum; fewer studies measure the surface alteration of the enamel surface and the effect of time of exposure. Hence, this "*in-vitro* study aims to compare the surface roughness of enamel after air polishing with different powders at different time intervals.

MATERIALS AND METHODS

In this experimental study, 80 freshly extracted teeth (incisors and premolars) of the maxillary and mandibular arch were collected from the department of Oral and Maxillofacial Surgery, Luxmi Bai Institute of Dental Sciences and Hospital, Patiala (Punjab).

The sample size was estimated based on previous studies and using the following formula:

- n= r+1/rSD2(Zβ-Zα)2/(d)2
- n=Sample size,
- r=1, (r+1)/r= 2, SD= 0.05, Zβ=0.95, Zα= 1.96, d=0.6

The study was approved by the Ethical Committee of Luxmi Bai Institute of Dental Sciences and Hospital, Patiala (letter no.BFUHS/2K21/p- TH/2954) Paired t-test was used for the intra-group analysis i.e. for varying time periods and unpaired t-test was used for the statistical analysis of intergroup comparisons i.e. between 40 samples of each group.

Paired t-test was used for the intragroup analysis i.e. for varying time periods and an unpaired t-test was used for the intergroup comparisons.

Inclusion Criteria

1. Patients aged between 15 to 35 years with no periodontal problems.
2. Freshly extracted incisors and premolars of maxillary and mandibular arch indicated for extraction having buccal surfaces devoid of any caries or periodontal problem.

Exclusion Criteria

1. Tooth with any abnormalities like hypoplasia, fluorosis, or decalcification.

2. Any fractured or cracked tooth.
3. Tooth with caries or restoration.
4. Tooth with abrasion, erosion or attrition

Methodology

All 80 tooth samples were randomly divided into 2 major groups. Each group was further divided into 2 subgroups.

Group 1: Air polishing was performed with Sodium bicarbonate powder

- Subgroup 1(SB1): exposure time for polishing is 15 seconds
- Subgroup 2(SB2): exposure time for polishing is 30 second

Group2: Air polishing was performed with Glycine

- Subgroup 1(G1): exposure time for polishing is 15 seconds
- Subgroup 2(G2): exposure time for polishing is 30 seconds

The distance and angulation of the nozzle of the Prophy-jet from the tooth surface were kept constant i.e. 5mm and 90◦ respectively with the help of a prefabricated apparatus, so as to maintain the sweeping motion of the nozzle. The water and air inlet pressure was maintained between 25 psi to 60 psi and 65 psi to 100 psi respectively with the help of a pressure gauge.

The roughness of the enamel surface was measured in micrometers (μ) as average roughness (Ra), defined as the mean between peaks and valleys of the surface profile. For this purpose, an enamel section on the buccal surface 3mm above the CEJ and 4mesiodistally, on the center of the crown was considered the selected area, remaining tooth was covered with an adhesive tape and mounted on a heat cured block with the help of elastomeric material (putty). The stylus of the profilometer was put in contact with the tooth specimen and the roughness of the surface was evaluated after calibrating it against a standard object.

Scanned Electron Microscopy (SEM): After the samples were mounted on metal stubs and dried, they were sputter coated with gold and visualized under a Scanned Electron microscope. The SEM photomicrographs were taken at X1000 magnification and 20 KV setting for each specimen at random by a technician who was blinded to the results of the study. The data thus obtained was put to statistical analysis.

➢ Method of assessing roughness & loss of tooth substance Score[3]

1. No abrsion: Smooth normal enamel.
2. Mild abrasion: Few micro pits or prism ends (ameloblastic pits) visible between perikymata lines.
3. Severe abrasion: Distinct perikymata lines, many prism ends and/or micro pits visible on the whole surface, occasional fracturing of perikymata edge.

RESULTS:

The results obtained in the study were statistically analyzed using:

1. Mean
2. Standard Deviation
3. Paired 't-test for intragroup analysis
4. Unpaired 't-test for intergroup analysis
5. Chi-square test

Table 1: On comparison of the mean values before and after air polishing for Group 1 SB1, the mean difference came out to be 1.447±0.921 and the p-value is 0.001 which is highly significant as in figure 1. Also, the comparison of the mean values before and after air polishing for Group 1 SB 2, showed a significant mean difference of 1.604±0.844, and the p-value is 0.00 which is highly significant as shown in Table 1 and figure 2.

In Table 2: On comparison of the mean difference values before and after air polishing for Group 2 SB1, the mean difference came out to be 0.489±0.756 and the p value 0.466 i.e. non-significant as shown in figure 3. Similar results were found on comparing the mean values before and after air polishing for Group 2 SB 2, figure 4 as the mean difference came out to be 0.496±0.926 and p value is 0.318 which is not significant.

In Table 3, figure 5, inter-group comparison for time=15 seconds showed that scores 2(55%) and 3(40%) were more frequently seen in Group 1, and Scores 1(15%) & 2(55%) were more frequent in Group 2. After statistical analysis p value is 0.762 which is not significant.

In Table 4, figure 6, inter-group comparison for time=30 seconds, Score 3 was more frequent (45%) in Group 1 and less frequent (30%) in Group 2. After statistical analysis p value is 0.003 which is significant. Score 1 was more frequently (20%) observed in Group 2 in comparison to Group 1(5%).

DISCUSSION:

Polishing aims to remove biofilm, stains, and pellicle present on the enamel and cementum surface to provide the smoothest surface possible. SRP alone is not efficient to reduce the surface roughness to the extent as achieved in combination with polishing. Studies done by Walker SL, et al in 1976 [4] and Madan C, et al in 2009 [5] have shown that scalers, curettes, and ultrasonic instruments are effective in removing subgingival plaque but didn't produce a smooth surface, leading to microbial colonization and progression of periodontal disease.

Although polishing with a rubber cup and paste is the most practiced method, it is gradually being replaced by an air-powder polishing device [3]. Willman D et al in 1980 [6] in their study stated that Air polishing, Rubber cup polishing, and ultrasonic scaling altered polished enamel surface to the same degree but later studies done by Boyde A et al in 1984 [7] found air polishing devices safer on intact enamel surfaces, and Galloway SE and Pashley DH in 1987 [8] found the air polishing devices to be less abrasive to enamel than rubber cup polishing with pumice.

This study was conducted in accordance with the. Only a specific part of the enamel surface was selected for the air polishing i.e. 4mm length and 3mm width from the CEJ. This was done as the thickness of enamel is maximum in the mid-buccal area and decreases to the cervical part and it is least at the CEJ.

Although polishing aims at making the tooth surface smooth, the results obtained in the present study indicate that the surface roughness of the intact enamel is increased after performing air polishing procedure. This is in accordance with the studies conducted by Bailey and Phillips [9], Kontturi-Närhi et al [10]. Hans[11], and Castanho et al [12]., demonstrating that air polisher increases the enamel surface roughness which in turn accumulates dental plaque. The abrasiveness may be due to the irregular shape & sharp edges of sodium bicarbonate particles, and high pressure of the air polisher with which the particles are blasted on the tooth surface.

Other studies conducted by Leknes, et al [13]. and Patil et al [14]. demonstrated that air powder polishing reduces both surface roughness and debris on enamel and cementum surfaces. However, the present SEM study demonstrated that the surface roughness of enamel was increased with an air polisher when used on a clean tooth surface. In table 1, comparing the surface roughness values of the surface profilometer before and after air polishing for 30 seconds, the results were highly significant. The results are similar to the studies done by Castanho et al in 2008 [12] and T.T. Yildirim et al.

in 2021 [15] in which they found that surface roughness increases after air-polishing the enamel surface with sodium bicarbonate powder (grain size 62 μ, Air-Flow Classic, Ems Sa) as measured by a surface profilometer. Bahadur S. et al in 1990 [16] also stated the importance of particle size and shape in causing surface roughness. Fratolin MM et al [17] in 2014 also observed significant surface changes after air polishing with sodium bicarbonate. On the contrary, some studies reported no enamel loss after doing sodium bicarbonate air polishing when compared to other polishing techniques (Arefnia B et al. 2021)[18], and little enamel loss was observed in other studies (Babina K et al in 2021)[19]. In table 1. B, (group 1 subgroup 1) when air polishing with sodium bicarbonate was done for 15 seconds, the mean average Roughness (Ra) change difference of the enamel surface came out to be 1.447±0.921 (statistically significant). Though the mean difference change was less than those obtained in Group 1 SB2. This can be due to less time of exposure. Group 2 (Glycine air polishing) showed statistically non-significant results on comparing the mean of surface profilometer readings both for 15 and 30 sec, though surface roughness increased in both cases after air polishing. Similar results were obtained in other studies (Fratolin MM et al in 2014)[17] concluding that the abrasiveness of Air Polishing powders depends upon the length of treatment and the type of powder used. Also, Peter Silka GJ et al in 2003[20] stated that glycine is a low abrasive polishing agent and can be used for subgingival plaque removal. Another study by Barnes C.M. et al in 2014[21] also revealed that the least amount of change in surface characterization was found on the enamel that was treated with the EMS glycine, followed by sodium bicarbonate, though both the powders were statistically non-significant when compared with each other.

In many studies scanning electron microscope was used to evaluate the surface changes caused due to instrumentation or polishing. (Sinjari B et al 2019 [22], Kontturi-Narhi V et al 1990 [10], Besnard C., et al 2021 [23], Barnes C.M. et al 2014 [21], Boyde 1975[24])

On observing the frequency of each Score in the results, it was found that Grade 2 and Grade 3 were more common in Group 1 and less frequently present in Group 2, however, no significant relation was found after statistical analysis. SEM analysis showed significant surface changes when air polishing was done for 30 seconds, in both the groups, i.e group 1 and group 2, as mild to severe abrasion of the enamel surface was seen in these SEM images when polishing time is increased, irrespective of the polishing powder used. Grade 3 was more frequently observed (45%) in Group 1 as compared to Group 2 (30%), giving an idea that EMS AIRFLOW may be little more abrasive to the enamel surface.

The results obtained after SEM analysis showed that the enamel surface alterations caused by Sodium Bicarbonate (EMS AIRFLOW classic) are maximum in comparison to the Glycine (EMS AIRFLOW perio) air polishing as verified by surface profilometer and viewed under SEM. Also, the time of exposure of the polishing powder seems to play an important role in causing surface alterations when doing air polishing as more images with distinct perikymata lines, micro pits, and fracture lines were observed in the samples in which air polishing was done for 30 seconds.

CONCLUSIONS:

It may be inferred that glycine is a better polishing agent for routine use in patients as compared to Sodium Bicarbonate and the time of exposure of the polishing powder is directly related to the surface roughness of the enamel surface. Therefore polishing time should not exceed 15 seconds in either case.

However, future studies with larger sample sizes, suitable forms (size & shape) of polishing agents, and advanced polishing devices are needed. Moreover, the results of an *in-vitro* study, can't be generalized completely to *in-vivo* conditions. Hence, future clinical trials with long-term in-vivo studies using other abrasive agents and newer air powder polishing systems could be tested.

Table1: Comparison of mean scores of Group1 (SB1 and SB 2) before and after air polishing

Time Intervals		N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	95% Confidence Interval of the Difference		t-test	p value
							Lower	Upper		
Time: 15 Sec	Before AP	20	3.306	1.941	0.434	1.447±0.921	-2.096	-0.798	4.667	0.001 (HS)
	After AP	20	4.753	2.861	0.640					
Time: 30 Sec	Before AP	20	2.946	0.782	0.175	1.604±0.844	-2.259	-0.948	5.120	0.001 (HS)
	After AP	20	4.549	1.626	0.364					

Table 2: Group 2

Table 2: Comparison of mean scores of Group 2 before and after air polishing

Time Intervals		N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	95% Confidence Interval of the Difference		t-test	p value
							Lower	Upper		
Time: 30 Sec	Before AP	20	3.386	1.867	0.417	0.489±0.756	-1.864	0.886	0.744	0.466 (NS)
	After AP	20	3.584	2.622	0.586					
Time: 15 Sec	Before AP	20	3.088	1.292	0.289	0.496±0.926	-1.508	0.516	1.025	0.318 (NS)
	After AP	20	3.584	2.218	0.496					

Table 3: SB1 (15 sec)

Table 3: Intergroup Comparison of SB 1

Roughness Scores	Glycine		Sodium Bicarbonate		X^2	p value
	Frequency	Percentage	Frequency	Percentage		
1	3	15%	1	5%	1.860	0.762 (NS)
2	11	55%	11	55%		
3	6	30%	8	40%		
Total	20	100%	20	100%		

Table 4:SB2 (30sec)

Table 4: Intergroup Comparison of SB2 of G1 and G2

Roughness Scores	Glycine		Sodium Bicarbonate		X^2	p value
	Frequency	Percentage	Frequency	Percentage		
1	4	20%	1	5%	16.015	0.003 (S)
2	10	50%	10	50%		
3	6	30%	9	45%		
Total	20	100%	20	100%		

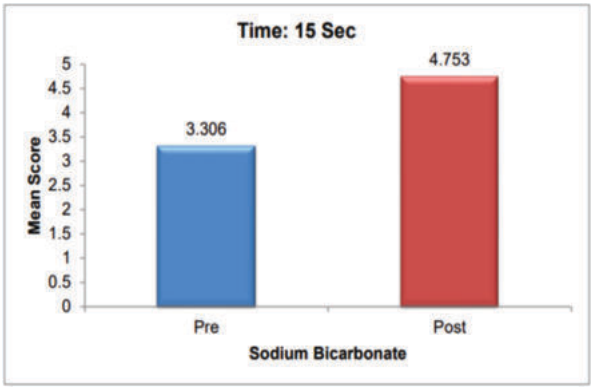

Figure1: Graph showing comparison of mean scores of Group 1 Subgroup 1 before and after air polishing

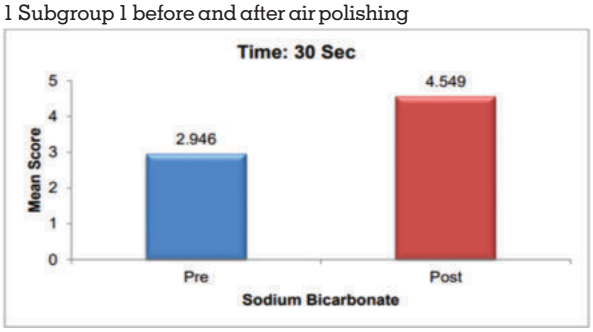

Figure 2: Graph showing comparison of mean scores of Group 1 Subgroup2 before and after air polishing

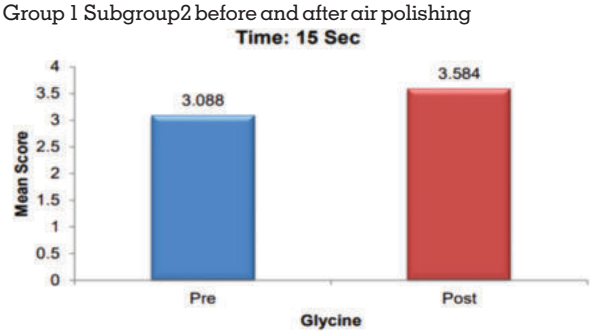

Figure3: Graph showing comparison of mean scores of Group 2 Subgroup 1 before and after air polishing

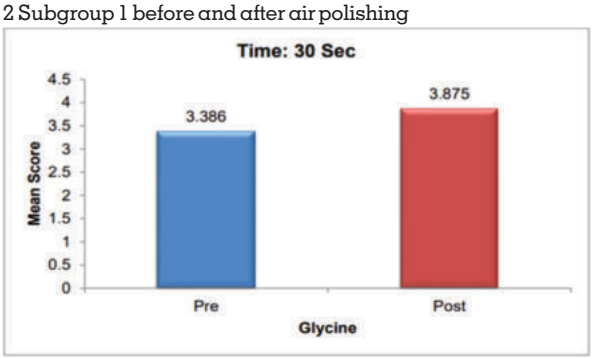

Figure 4: Graph showing comparison of mean scores of Group 2 Subgroup 2 before and after air polishing

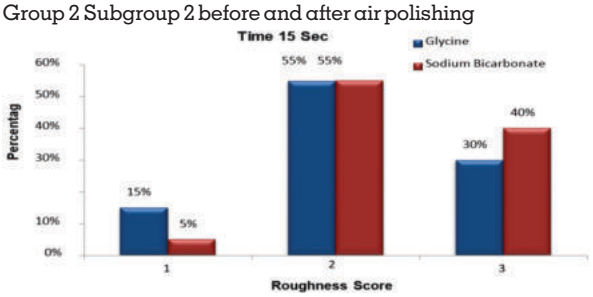

Figure 5: Graph showing Inter-group comparison of frequency percentages of SEM scores

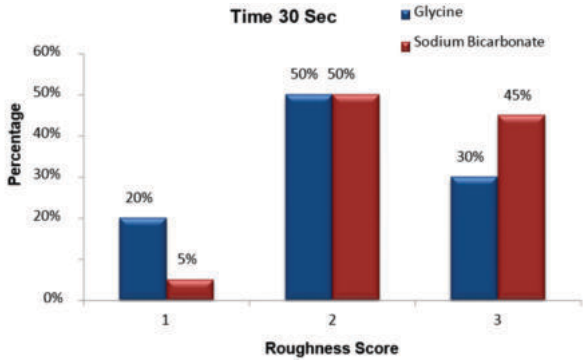

Figure 6: Graph comparing the frequency percentage of Roughness Scores in Group1 and Group 2

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