

## ORIGINAL RESEARCH

## Surface Roughness on Dental Tissues by Abrasives – An In-Vitro Study

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## ABSTRACT

**Introduction:** Air-powder polishing devices are increasingly used for stain and plaque removal. However, besides cleaning the tooth surface, they may increase the surface roughness of the dental tissues. This in turn may result in plaque accumulation and superficial degradation. Thus the aim of this study was to assess the influence of three different abrasive agents: Pumice, Sodium bicarbonate and Calcium carbonate on the root surfaces using surface roughness tester & scanning electron microscopy (SEM).

**Material and Methods:** Thirty extracted teeth were scaled and root planed, stored in saline and embedded in acrylic resin. Baseline values for surface roughness for root surface and implants were taken using a surface roughness tester. The samples were then randomly divided into three groups of ten each: Group I were treated using pumice with a rotating rubber cup. Group II and Group III with sodium bicarbonate and calcium carbonate powder respectively with an air-powder polishing device. The surface roughness of each sample was again measured using the surface roughness tester and was confirmed using SEM.

**Results:** Surface roughness values for root and implant increased for pumice and sodium bicarbonate whereas decreased for calcium carbonate from the baseline. Surface roughness for pumice was not statistically significant while for sodium bicarbonate and calcium carbonate; was significant. SEM analysis showed that sodium bicarbonate produced roughest surface and calcium carbonate produced smoothest surface.

**Conclusions:** Within the scope of this study, we can conclude that calcium carbonate powder produces smoothest root surface and thus can safely be used for polishing.

**Keywords:** Air polisher device, air abrasion, sodium bicarbonate, calcium carbonate, pumice, scanning electron microscopy.

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## INTRODUCTION

The dental plaque is considered a complex bacterial ecosystem that undergoes evolution, maturation and development leading to infections.<sup>1</sup> Various prophylaxis methods are used to mechanically remove plaque and stains from tooth surfaces. Polishing agents used in stain removal are used as a “selective procedure”. Not every patient needs it, especially on regular basis, as continuous polishing over time causes morphological changes in teeth by abrading tooth structure, in addition to fluoride in outer enamel layer. During the initial or supportive periodontal therapy, polishing devices such as rotating rubber cups or bristle brush using an appropriate abrasive powder (pumice) or air powder polishing devices are frequently used for professional supragingival plaque removal.<sup>2</sup>

The air-powder polishing device is increasingly used for easy, rapid and complete stain and plaque removal. “It is the process of cleaning and polishing the dentition and dental restorations using a device that mixes air and water pressure with an abrasive agent to remove extrinsic stain and plaque”. It can produce uniformly smooth root surfaces and removes 100% bacteria and bacterial endotoxins from cementum.<sup>3</sup> It has been reported that the use of air-polishing device is more efficacious and time-saving compared to rubber cup with pumice.<sup>3,4,5</sup>

Sodium bicarbonate powder is the first acceptable gold standard powder for air-polishing. Nowadays, various new powders are available for use such as glycine, calcium carbonate, calcium sodium phosphosilicate, etc. Calcium carbonate powder comes with micro-sphere technology and shows reduced gingival irritation. It has neutral taste and is more pleasing to the patient.

Mette S Agger evaluated the abrasiveness of a prophylaxis system along with sodium bicarbonate on root surfaces in vitro by use of scanning electron microscopy and laser profilometry. The air polisher had a strong abrading effect on exposed root surfaces. However, most of the dentinal tubules were obliterated.<sup>6</sup>

Petersilka GJ *et al* assessed the influence of time, distance and angulation (working parameters) on root damage using air-powder polishing devices (APD). They observed that root damage varied among combinations of working parameters and under all parameter combinations, air-polishing with sodium bicarbonate led to substantial root damage. Thus APD with sodium bicarbonate may not be safely used on exposed root surfaces.<sup>7</sup>

Poliano Mendes Duarte *et al* evaluated the roughness and

adherence of *S. sanguis*, after treatment of smooth & rough titanium surfaces with: Erbium-doped: yttrium, Aluminium & garnet (Er:YAG) laser, Metal and plastic currettes and an Air-powder abrasive system. The roughest surfaces were produced by metal currettes. Metal currettes and air-powder system showed lowest level of bacterial adhesion.<sup>8</sup>

Matthias Pelka *et al* evaluated the influence of air-polishing devices and various abrasives i.e. sodium bicarbonate, calcium carbonate and glycine powder on flat root surfaces. The abrasiveness of air-polishing powders differed depending on the polishing device used. All abrasives except glycine caused substantial volume loss and root surface damage.<sup>9</sup>

The issue still remains as to the type of abrasive agent that could remove stains and plaque safely and could be used on the root surface in periodontitis patients. Also, treating root surfaces with various abrasive powders may cause serious substance loss and surface roughness, especially when considering cumulative damage during supportive periodontal treatment over years.<sup>6</sup> Surface roughness is important on cervical sites with gingival contact, which favours constant plaque accumulation, especially on proximal sites which in turn enhances development of gingival inflammation.<sup>9</sup>

Thus the aim of this study was to assess the influence of three different abrasive agents: Pumice, Sodium bicarbonate and Calcium carbonate on the root surfaces using surface roughness tester & Scanning Electron Microscopy.

## MATERIALS AND METHODS

Thirty maxillary and mandibular extracted teeth were taken. They were thoroughly scaled and root planed using ultrasonic scaler, then stored in saline and embedded in acrylic resin. (Fig 1) Baseline values for surface roughness were taken using a surface roughness tester in an area on root surface just near the cervical aspect on the proximal side (Fig 2). Along with the root surface, baseline readings for the surface roughness of implants were also measured using the same tester. The samples were then randomly divided into three groups of ten each:

Group I: Pumice with a rotating rubber cup for thirty seconds in a contra-angle slow handpiece.

Group II: Sodium bicarbonate powder in an air-powder polishing device.

Group III: Calcium carbonate powder in an air-powder polishing device.

For group II and group III, treatment time was 30 seconds. The distance between the outflow opening of the handpiece and root surface was kept constant at 4 mm. Angulation of the nozzle was 90 degrees. The powder chamber of the handpiece was always filled to the maximum level to guarantee constant powder flow.

The average surface roughness (Ra) of each sample was then again measured using the surface roughness tester and the surface topography of one sample from each test group was characterized by scanning electron microscopy (SEM).

## STATISTICAL ANALYSIS

All the data were analyzed using t-test for paired observations. Statistical significance was set at  $P < 0.05$  with a confidence interval of 95%.

## RESULTS

Surface Roughness readings (Ra) ( $\mu\text{m}$ ): The values for pumice as well as sodium bicarbonate powder increased from the baseline, while for calcium carbonate they decreased. (Table 1)

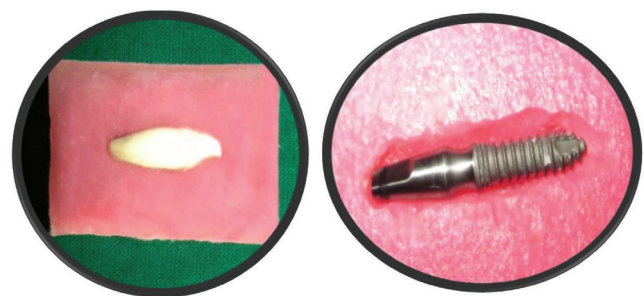
Surface roughness readings for implant: (Ra) ( $\mu\text{m}$ ): The results obtained were similar to the tooth surface values, i.e. for pumice and sodium bicarbonate powder it increased from baseline and decreased for calcium carbonate. (Table 1)

The differences in values for surface roughness from baseline to after treatment were statistically analyzed. The increase in mean surface roughness value for pumice was not statistically significant ( $P=0.26$ ), whereas for sodium bicarbonate it was statistically significant ( $P < .001$ ). The decrease in mean surface roughness for calcium carbonate was statistically significant ( $P < .001$ ). (Table 2)

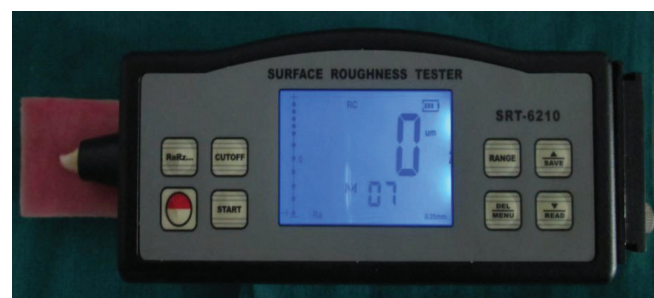
Scanning Electron Microscopy analysis: Among the three powders, sodium bicarbonate produced roughest surface and calcium carbonate produced smoothest surface. (Fig 3)

## DISCUSSION

Surface roughness is a measure of the texture of a surface. In periodontal therapy emphasis has always been placed upon



**Figure-1:** Specimen embedded in resin for measurement of surface roughness using surface roughness tester



**Figure-2:** Surface roughness tester placed over the specimen, which gives out a digital reading of the surface roughness of the specimen

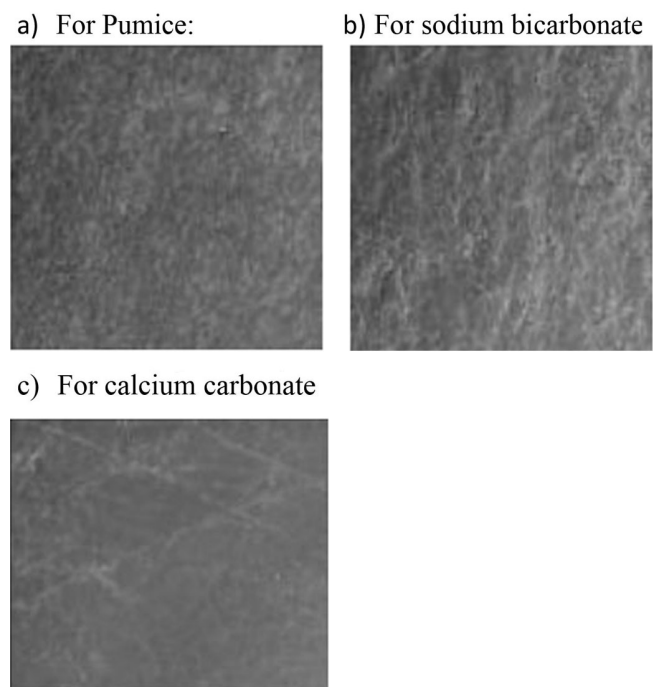
the elimination of root roughness as roughened surfaces facilitate plaque accumulation.<sup>10</sup> So this study assessed the surface roughness of different abrasive agents on the root surface and implant by surface roughness tester and SEM. Calcium carbonate produced the smoothest surface and sodium bicarbonate produced roughest surface on both root surfaces as well as on the implant. Scanning electron microscopy confirmed the results obtained by the roughness tester. The abrasiveness of the different agents depends on various factors like particle size and shape, hardness, contact time, pressure and speed.<sup>11,12</sup> The contact time was kept constant in the present study. The pressure and speed were kept constant for the air-polishing device. The particle shape of sodium bicarbonate powder is irregularly shaped with sharp edges while the calcium carbonate powder has smooth, spherical shape.<sup>9</sup> This might have caused variation in the roughness seen with the two. The average particle size of sodium bicarbonate powder is 74µm,<sup>12</sup> calcium carbonate powder is 45µm,<sup>9</sup> and for pumice is 65µm. Smaller (finer) the grit, smaller the scratches, which

means the shinier the tooth surface will be after polishing. This coincides with the results obtained. Based on the Mohs scale, the hardness for pumice is 6-7, for calcium carbonate is 3 and for sodium bicarbonate it is 2.5.<sup>12</sup> Darby *et al* in 2010 stated that harder the abrasive material more will be its abrasiveness and rougher the surface that will result. However, even a very hard material will be minimally abrasive if used as a very fine particle size (grit). The limitations of this study are that the sample size was small and the efficacy of stain removal of these abrasives was not evaluated.

**CONCLUSION**

Within the scope of this study, we can conclude that calcium carbonate powder produces smoothest root surface and thus can safely be used for polishing. In-vivo study needs to be conducted to evaluate if the roughness caused by these abrasives causes increased plaque accumulation. Further

Pumice		Sodium bicarbonate		Calcium carbonate	
Roughness values on tooth surface					
Base-line	After Rx	Base-line	After Rx	Base-line	After Rx
2.757	2.501	1.587	2.605	1.618	1.112
1.570	1.628	1.192	3.128	2.012	1.102
1.820	2.218	2.412	3.927	1.525	0.821
1.457	1.157	1.498	1.918	2.423	1.512
1.214	1.380	1.212	2.283	1.285	1.172
2.525	2.885	1.918	2.728	1.726	0.587
1.216	2.186	2.128	3.998	1.818	1.217
1.580	1.310	1.392	2.918	2.363	1.021
1.368	1.228	1.727	2.028	1.587	0.238
2.363	1.998	2.477	3.018	1.687	0.927
Surface roughness values on implant surface					
Base-line	After Rx*	Base-line	After Rx*	Base-line	After Rx*
0.583	0.601	0.423	0.625	0.599	0.483
*After Rx = After treatment, The surface roughness values for pumice as well as sodium bicarbonate powder increased from the baseline, while for calcium carbonate they decreased.					
<b>Table-1:</b> Surface Roughness readings for tooth surface and implant surface (Ra) (µm) using a surface roughness tester					



**Figure-3:** a: Scanning electron microscopy analysis for pumice; b: Scanning electron microscopy for sodium bicarbonate powder; c: Scanning electron microscopy for calcium carbonate powder

Abrasive used	Reading at	Mean	Standard deviation	Standard error	t-value	P-value	Remark
Pumice	Baseline	1.7869	0.5623	0.1483	-1.201	0.26	Non-significant
	After	1.9651	0.4946				
Sodium Bicarbonate	Baseline	1.8263	0.4235	0.1638	-6.281	<.001	Significant
	After	2.8551	0.7093				
Calcium Carbonate	Baseline	1.8057	0.3625	0.0947	7.852	<.001	Significant
	After	1.062	0.1233				
The differences in values for surface roughness from baseline to after treatment were statistically analyzed. The increase in mean surface roughness value for pumice was not statistically significant (p=0.26), whereas for sodium bicarbonate it was statistically significant (P < .001). The decrease in mean surface roughness for calcium carbonate was statistically significant (P < .001).							
<b>Table-2:</b> Statistical analysis using paired t-test for pumice, sodium bicarbonate and calcium carbonate powder							

study needs to be done to evaluate the effect of air polishing on implant surfaces. It is likely that there will be many new developments that will enhance the use and efficacy of air polishing in the very near future.

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