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Influence of scaler tip design on root surface roughness : An invitro study

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Abstract:

Objectives: To investigate the influence of two different scaler tips on root surface roughness following piezoelectric ultrasonic scaling using laser profilometer. *Methods:* In this in vitro study, root surface roughness was measured before and after scaling with Universal scaler tip (type A) and Perio-probe like tip (type PS) scaler tips using a 3D optical profilometer. Fifteen mandibular and maxillary premolars extracted for orthodontic reasons were selected for this study. Statistical analysis was done using student's' test. *Results:* Statistically significant difference was found between the two groups before and after scaling was done. Group A showed rougher surface than group B in this study. *Conclusion:* Roughness produced on the root surface by scalers the tips after scaling is inversely proportional to the surface area of scaler the tips.

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Key Words: Optical Profilometer, Universal Scaler tip, Perio-Probe type, root surface roughness

Introduction

Studies on plaque accumulation showed a positive correlation between roughness of root surface and plaque growth, with more plaque accumulating on a rougher root surface.[1] Flemmig et al 1998a, b evaluated tooth substance removal by different ultrasonic devices and suggested that magnetostrictive unit was more aggressive than piezoelectric device regarding root substance removal. Gankerseer and Walmsley 1987 showed that different surface alterations could be expected from different working tip designs since the tip geometry may significantly influence the displacement amplitude.

Present in vitro study evaluated the effects of different piezoelectric ultrasonic tip designs on root surface roughness post scaling.

Material and Methods:

Collection of Experimental Sample:
Fifteen mandibular and maxillary premolars extracted for orthodontic reasons were selected for this study. After extraction, teeth were rinsed with water for approximately 60 seconds and placed in 10% formalin.

Tips used in this study: Piezo electric ultrasonic scaler tips 1) Universal scaler tip (Type A) and 2) Perio-probe like tip (Type PS) are used. (Table-1).

Selection Criteria:
All teeth had to meet the following criteria:

Inclusion Criteria:

- Teeth extracted for orthodontic purpose
- Intact root surface
- Absence of caries
- No history of periodontal involvement
- Absence of gross hard and soft tissue debris
- Relatively flat surface

Exclusion Criteria:

- Teeth with root concavities or convexities which impeded proper planing of root surfaces were excluded.
- Teeth extracted due to any other reasons

Mounting Procedure:

The teeth were mounted in a 2 cm high plastic tube filled with cold cure acrylic resin with the most even (Mesial or Distal) surface exposed (Figure 1). Mounted teeth were numbered from 1 to 15 randomly. To avoid reading localization error a 4 X 4 mm area at the face of each root was delineated as the reading area. An imaginary line was drawn parallel to the long axis of the tooth at the center between buccal and lingual/palatal surface and labeled group A and group B respectively.

Pre-instrumentation roughness reading:

Surface roughness was characterized using a 3D Optical profilometer (Veeco NT1100) and the roughness parameters were

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calculated using the ANSI standard (Figure 2). The surface roughness parameters used in this study are R_a and R_Z. R_a is defined as the arithmetic mean of the absolute values of vertical deviation from the mean line through the profile. The mean line is the line such that the area between the profile and the mean line above the line is equal to that below the mean line. The R_a was calculated over the entire measured array as per the ANSI B46.1 standards and is given by the expression,

$$R_a = \frac{1}{n}\sum_{i=1}^{n}(z_i - \bar{z})$$

, Where, n is the number of data points on the profile, z and $\bar{z}$ are the data points on the profile and the average respectively,[2] and Rz is defined as ten points i.e. the average absolute value of the five highest peak and the five lowest valleys over the evaluation length and is calculated by

$$Rz = \frac{(P1+P2\ldots P5)-(V1+V2\ldots V5)}{5}$$

Root Scaling:

Scaling was done by using piezoelectric ultrasonic scaler tips i.e. perio-probe like tip (Type PS) and universal scaler tip (Type A) on root surface of group A and group B respectively. Fifteen strokes in an apico-coronal direction with zero degree inclination between scaler tip and root surface of teeth was carried out by the same operator to avoid errors. Medium speed was used with water cooling according to the manufacturer's instructions (Figure 3).

Post-instrumentation roughness evaluations:

A roughness reading was performed again on all treated roots in the same location where the pre-instrumentation roughness was measured to determine a mean roughness for each treated root surface with a magnification of 40 X.

Statistical Analyses: Differences in roughness means after instrumentation were evaluated by using student-paired‘t’ test ($p< 0.05$).

Results:

Roughness: All treated groups (group A and group B) showed an increase in roughness compared to pre-instrumentation but not statistically significant with respect to Ra ($p<0.05$) compared to the pre scaling group (Table-2). Statistical significant results was found with respect to Rz ($p<0.05$) compared to the pre scaling group in group A treated with perio probe type of tip compared to group B, treated with universal scaler tip(Table-3). Graph 1&2 shows more roughness after scaling compared to before scaling in relation to (R_a) and R_z values in group A (type A scaler tip). Figure 4 and 5 shows same variations. Graph3&4 shows more roughness after scaling compared to before scaling in relation to (R_a) and R_z values in group B (type PS scaler tip). Figure 6 and 7 shows same variations.

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Table 1 :

Ultrasonic scalers and scaler tip designs used in the present study		
System	**Mode of action**	**Tips**
Mini Piezon	Piezoelectric	Probe like tip (Type PS)
		Universal tip (Type A)

Table 2:

Paired Samples Statistics			
Group	**Mean**	**S.D.**	**S.E**
Group A			
Pre Ra	0.910	0.44	0.11
Post Ra	1.129	0.52	0.13
Group A			
Pre Rz	8.554	2.74	0.71
Post Rz	9.948	3.24	0.83
Group B			
Pre Ra	0.806	0.41	0.11
Post Ra	0.902	0.53	0.14
Group B			
Pre Rz	7.030	2.92	0.76
Post Rz	7.921	3.11	0.80

Table 3:

Paired Samples Test					
Groups	**Paired Differences**				
	Mean	**Std.Deviation**	**Std.Error Mean**	**t**	**p**
Group A. Pre Ra 1- Post Ra 1	-0.21913	0.417261	0.107736	-2.034	0.061
Group A. Pre Rz 1- Post Rz 1	-1.3947	1.96135	0.50642	-2.754	0.016*
Group B. Pre Ra 2 –Post Ra2	-0.09547	0.276819	0.071474	-1.336	0.213
Group B. Pre Rz 2- Post Rz 2	-0.8913	2.26700	0.58534	-1.523	0.150

P<0.05*

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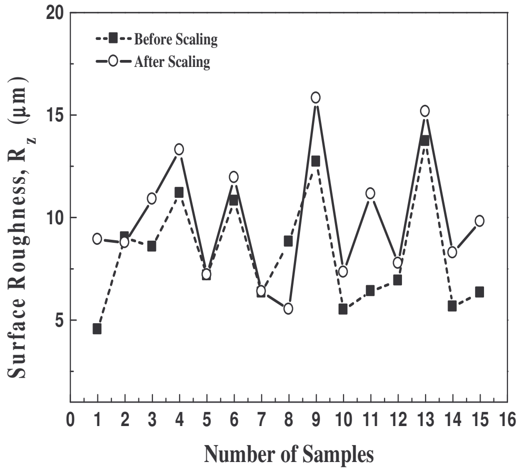
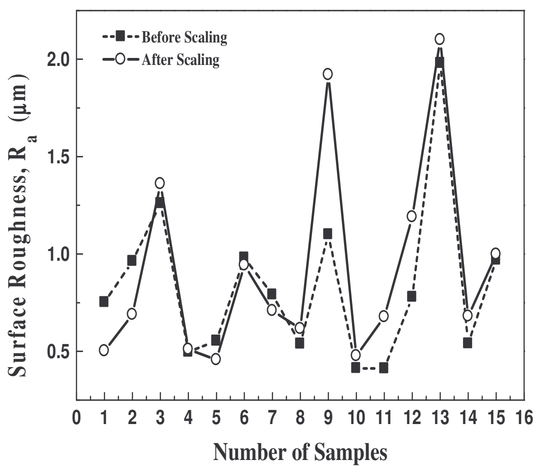
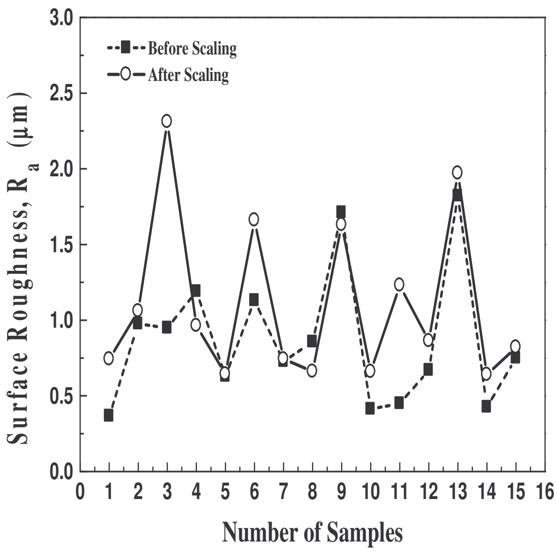
Graph 1: Variation of Surface roughness, (R_a), before and after scaling for different samples for Group A



Graph 3: Variation of Surface roughness, (R_a), before and after scaling for different samples for Group B



Graph 2: Variation of Surface roughness, (R_Z), before and after scaling for different samples for Group A



Graph 4: Variation of Surface roughness, (R_Z), before and after scaling for different samples for Group B

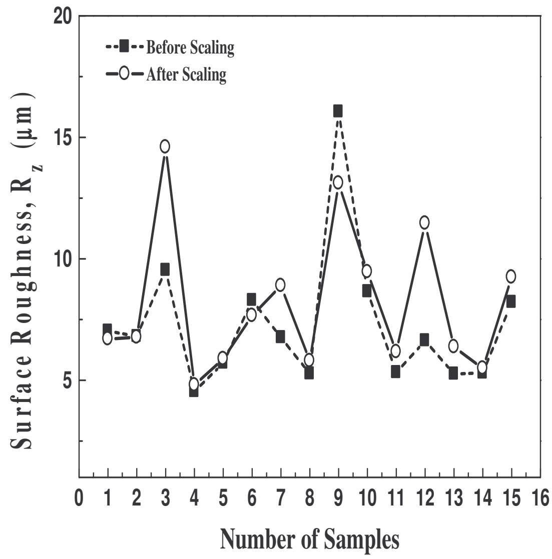


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Figure 1: Mounted Samples

Figure 2: 3D Optical Profilometer

Figure 3: Piezoelectric Ultrasonic Scaler Tips

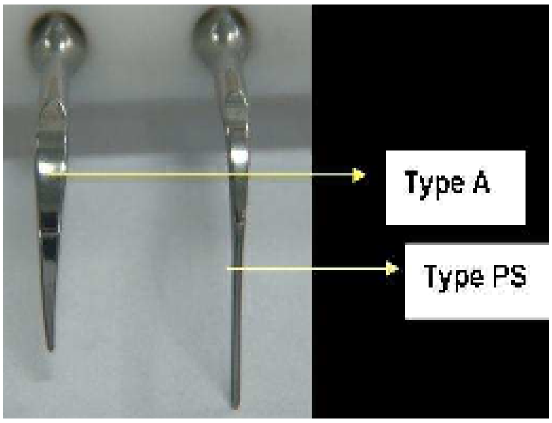


Figure 4: Before scaling in Group A

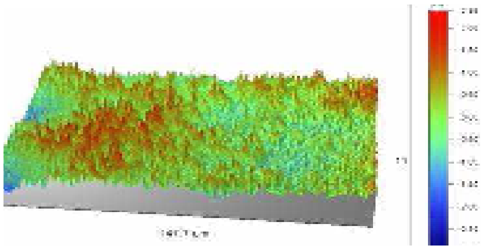


Figure 5 : After scaling in Group A

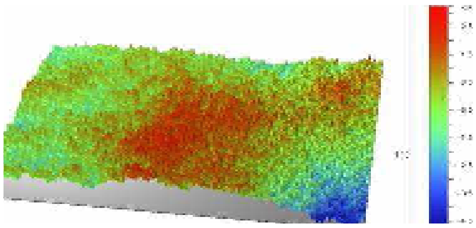


Figure 6 : Before scaling in Group B

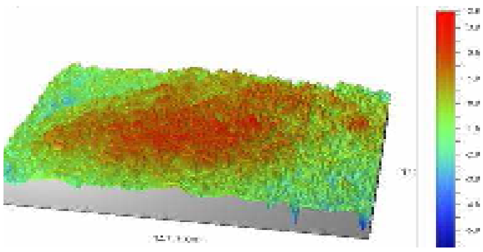
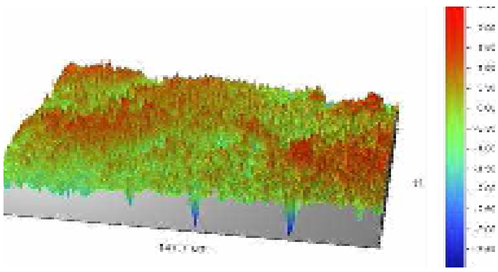


Figure 7: After scaling in Group B



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Discussion:

Ultrasonic scalers are becoming increasingly popular for sub gingival debridement due less strain for the operator and more comfort for the patients than handinstruments. It easy to insert in narrow pockets than curetts.[3] In the present study, the power of the ultrasonic devices was set at a medium level, which was recommended by Flemmig et al. (1998a, b) for clinical practice, and in medium speed it removes less cementum and causes less root damage than the higher speed.[4] In the present study we used 3D Optical laser profilometer to find out the root surface changes before and after the scaling. This instrument is the most sensitive device to analyze changes in the surface roughness. Ra is the most universally used roughness parameter for general quality control; this is easy to define, easy to measure, and gives a good general description of height variations. Rz is more sensitive to occasional high peaks or deep valleys than Ra. [5] We found increase in roughness on root surface compared to pre-instrumentation in both groups (Graph 1& 2). Results were not statistically significant with respect to Ra ($p<0.05$) compared to the pre scaling group but was statistical significant with respect to Rz ($p<0.05$ in group A which was treated with perio probe type of tip compared to group B treated with universal scaler tip (Figure 6&7).

Most of the studies have evaluated differences regarding the roughness produced by sonic, ultrasonic and hand instruments [6,4]. However, the angulations and design of instrument tip, sharpness of the working edge, the length of time the instrument is in contact with the root, and the cumulative numbers of strokes have impact on the degree of root damage. Teeth extracted for orthodontic purpose were selected for this study because premolars are most commonly extracted for during this treatment and cementum is healthy. In case of diseased teeth, the cementum will be softened[7] and tips may remove the cementum more aggressively and it may give false results.

Numerous studies have demonstrated that the most important prerequisite for healing after periodontal treatment is a root surface free of plaque and calculus (Nyman et al. 1975, Tagge et al. 1975, Rosling et al. 1976, Froum et al. 1982, Mierau25 (1984) and Quirynen and Bollen (1995) have clarified that supragingival rough surfaces subsequent to professional instrumentation can promote plaque formation and contribute to bacterial adhesion. Supragingival surface roughness and surface irregularities increase the surface area, promoting bacterial colonization, plaque formation and thereby compromising daily plaque removal.[8,9]

Leknes, et al.[10] (1996) demonstrated that roughness resulting from subgingival instrumentation significantly influenced the subgingival microbial colonization. Then, a smooth root surface may be advantageous near the gingival margin, since a smooth surface is less likely to accumulate plaque than a rough surface.

Japsen et al in 2004 did a similar study by using magnetostrictive and piezoelectric ultrasonic tips on the root surface, and concluded that significant increase in the aggressiveness to root dentin was seen for wide scaler tips as compared to narrow scaler tips. In contrast to that study, this study found root surface roughness is more aggressive by thinner scaler tip design than broader tip design.

Therefore, for clinical application, it can be assumed that a meticulous scaling and root planing procedure during initial cause-related therapy should be performed[11] and the long term success of this treatment is dependent on the quality of the maintenance therapy[12]. It is important that caution should be taken while utilizing these instruments and that a higher standard of supra gingival oral hygiene may be required for such patients. More studies are needed to clarify the influence of different ultra sonic tip design on root surface roughness.

Conclusion:

In this study root surface roughness were measured before and after scaling with type A and type PS scaler tips using a 3D optical profilometer. Within the limits of the present study it can be concluded that large surface universal ultrasonic tips produce less rough surface on the root surface than a thin probe type of tip. It means roughness on the root surface is inversely proportional to the surface area of the scaler tips.

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