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Research Article

Micromorphologic Evaluation Efficacy of Scaling and Root Planing of Periodontally Diseased Root Surfaces by Atomic Force Microscopy

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Abstract

In this article, micromorphologic evaluation efficacy of scaling and root planing of periodontally diseased root surfaces by atomic force microscopy is demonstrated. Post scaled and root planned roughness parameters of tooth and root surface was evaluated by 3D images of AFM. AFM revealed that SOM produced smooth root surface with marked exposure of dentinal tubules. 3 D images produced by AFM analysis proved that magnification enhances the efficacy of scaling and root planing.

Keywords: *Scaling and Root Planing; 3D Imaging; Atomic Force Microscopy (AFM); Scanning Probe or Force Microscopy (SPM)*

Introduction

Newly developed 3D imaging method Scanning Probe Microscopy produces magnanimous magnification of surface structures at sub-atomic resolution [1]. Atomic Force Microscopy (AFM) is a facsimile or replica (clone) of Scanning Probe or Force Microscopy (SPM). AFM provides topographical and morphological 3D image of a sample surface to analyse ipto depth of vertical resolution and lateral resolution until 0.1 nm.

Periodontal infection may be reduced through the mechanical plaque control [2]. However, various undesirable side effects of improperly done scaling and root planing can produce surface changes and side effects including increased root sensitivity, wasting diseases and gingival recession, and the formation of a smear layer [3].

Atomic Force Microscope (AFM) appears to offer 3D micromorphologic evaluation in this area. Samples such as teeth can be analyzed directly. Photoconductive Atomic force microscopy (AFM) or scanning force microscopy (SFM) is a very-high-resolution type of scan-

ning probe microscopy (SPM), with demonstrated resolution on the order of fractions of a nanometer, more than 1000 times better than the optical diffraction-limit. Till date no studies has been done and no reports are yet available describing the application of AFM and study of root surface changes in Periodontology [4-8].

Aims and Objectives

The objective of the present work was to study Micro morphology of root surface post SRP by Atomic Force Microscope.

Materials and Methods

This study was conducted in post graduate department of periodontology, hospital of Chandra Dental College, Safedebad, Barabanki, India. The research protocol has taken approval by the Research Ethical Committee.

Study design

This is a prospective and nonrandomized clinical trial which evaluates micromorphologic evaluation efficacy of SRP of periodontally diseased root surfaces by atomic force microscopy. Size of the sample selected was total 15 human teeth which are advisable for removal from 5 patients (3 teeth per patient) aged between 45 to 65 years old having Periodontal disease selected randomly to following 3 treatment groups:

1. **Group I:** Through scaling and root planing performed by ultrasonic scaler followed by hand instruments without using any magnification device.
2. **Group II:** Through scaling and root planing performed by ultrasonic scaler followed by hand instruments with the help of Magnifying Loupes of magnification 4.5 to 5.5 X.
3. **Group III:** Through scaling and root planing performed by ultrasonic scaler followed by hand instruments with Surgical Operating Microscopes of magnification 3.5X, 5.0X, 8.5X, 13.5X, 20.5X.

Micromorphologic evaluation efficacy of scaling and root planing of periodontally diseased root surfaces by atomic force microscopy was evaluated.

Clinical procedure

Detailed case history of all the patients was recorded. The areas of the work on the teeth were marked from cemento-enamel junction to gingival margin and then to the base of the periodontal pocket on all the four surfaces. Through scaling and root planing performed by ultrasonic scaler followed by hand instruments according to Group I, II and III. Teeth were then extracted atraumatically after suitable local anesthesia with the beak of extraction forceps, placed above the cementoenamel junction, avoiding any trauma to the worked/scaled surface. Teeth were rinsed thoroughly under running tap water and brushed lightly with an ultra soft bristle brush for removal of soft tissue tags. Teeth in three different groups were then placed in normal saline solution and transported for AFM analysis.

Samples for AFM analysis

Samples of 5 patients (total 15 sections) are prepared and stored in 0.9% sodium chloride solution to avoid drying and samples were taken to Indian Institute of Technology, Physics Department, Delhi for topographic analysis.

All the images and graphs were obtained by AFM Explorer manufactured by Veeco-Thermo Microscopes (USA) (type 1520-00, Veeco). In imaged surface area AFM generates images by scanning a small cantilever over the surface of a sample. The sharp tip on the end of the cantilever contacts the surface, bending the cantilever and changing the amount of laser light reflected into the photodiode. The height of the cantilever is then adjusted to restore the response signal resulting in the measured cantilever height tracing the surface.

AFM surface roughness evaluation

To define surface topography of sample, the following parameters were evaluated [9-11]:

1) Ra, which is the measurement of mean arithmetic roughness determined as the mean deviation of a section profile from the mean line by application of equation 1, where L is the length of the section and fx is the displacement function:

$$Ra = \frac{1}{L}\int_0^L |f(x)|dx. \qquad (1)$$

2) Ry is the measurement between peak maximum and valley minimum in a reference length of the roughness profile. Ry may thus indicate an erroneous view of the surface.

$$Rz = \frac{1}{5}\left(\sum_{i=1}^{5} pi + \sum_{i=1}^{5} vi\right). \qquad (2)$$

3) Rz is the measurement mean distance between five peak maximums and five valley minimums.

4) Obtained by application of equation 2 where pi and vi refer to the ith peak and valley, respectively.

5) Rms is the standard deviation between the x and y axes of a prescribed area as given by equation 3.

6) Rp is the measurement between the surface line and the maximum peak in the prescribed area.

7) Ry is the measurement between the surface line and the minimum valley in the prescribed area.

Results

AFM analysis: Post SRP naked eye sample

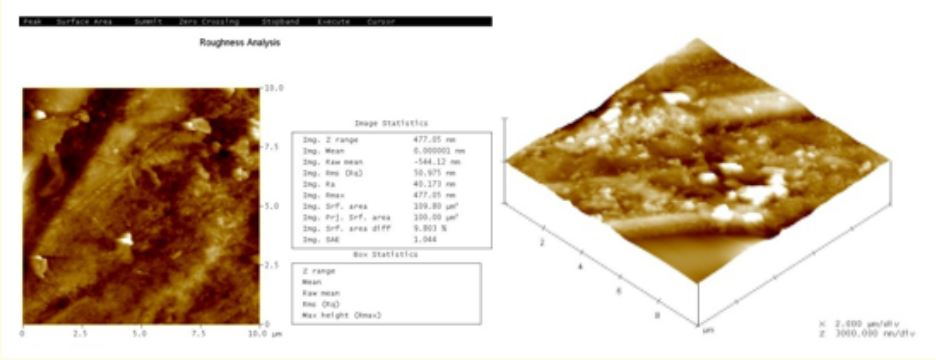

Figure 1: *Topographic analysis: Presence of debris, calculus and scratches all over the surface.*

Surface analysis results:

- Ra = 40.173 nm
- Rmax = Rz = 477.05 nm
- Rq = 50.975 nm
- Rmax = 477.05 nm.

AFM analysis: Post SRP loupe sample

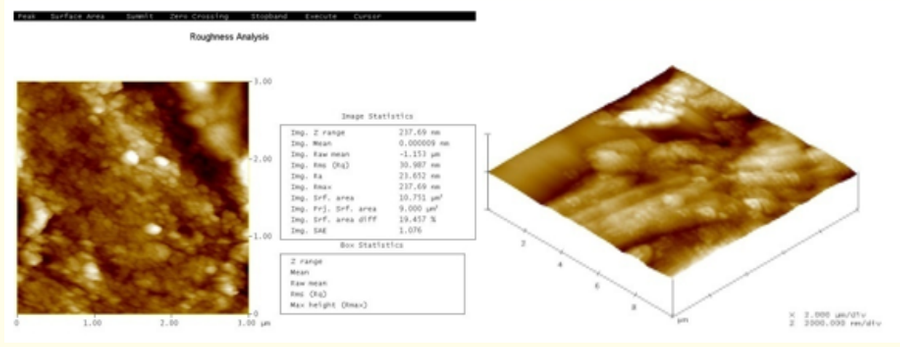

Figure 2: *Topographic analysis: Presence of smear layer with opening of dentinal tubules at some places.*

Surface analysis results:

- Ra = 23.652 nm
- Rmax = Rz = 237.69 nm
- Rq = 30.987 nm
- Rmax = 237.69 nm.

AFM analysis: Post SRP SOM sample

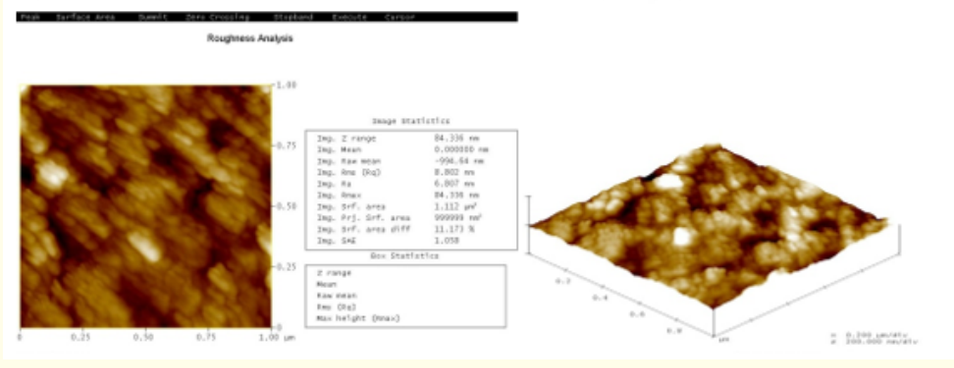

Figure 3: *Topographic analysis: clear surface with opening of dentinal tubules all over the surface.*

Surface analysis results

- Ra = 6.807 nm
- Rmax = Rz = 84.336 nm
- Rq = 8.802 nm
- Rmax = 84.336 nm.

Discussion

AFM can be applied in study of ultramorphology of superficial root surface [13-15]. The present aimed on micromorphologic evaluation efficacy of scaling and root planing of periodontally diseased root surfaces by atomic force microscopy and also evaluates the effectiveness of supragingival and subgingival scaling and root planing (SRP) under different magnifications.

Laknes., *et al*. analyzed and studied root surface roughness carried out with the AFM with high accuracy and demonstrated that roughness resulting from subgingival instrumentation significantly influenced the subgingival microbial colonization. In another study, he found that, subgingival roughness following surgery, without supragingival plaque control during healing, favored plaque retention and colonization. [16].

Although the AFM has been employed in other areas of dentistry, the specific advantages of the technique have not been previously described with respect to the study of root surface study for checking efficacy of scaling and root planing in order to facilitate the regeneration of periodontal tissue.

Conclusion

AFM revealed that SOM produced smooth root surface with marked exposure of dentinal tubules.

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