Evaluation of Root Surface of Periodontally Involved Teeth after Manual, Ultrasonic, and Diode Laser Instrumentation

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Abstract:
Background: Complete removal of calculus is an integral part of achieving a biologically acceptable tooth surface in the treatment of periodontitis. An ideal instrument should enable the removal of all superfluous substances from the root surface, without causing any iatrogenic effect. This study was conducted to compare the efficacy of calculus removal by hand instrument, ultrasonic scaler and hand instrumentation combined with diode laser on the root surface as well as to compare the iatrogenic effects caused by these instruments. To compare the efficacy of calculus removal as well as to compare the roughness and loss of tooth substance caused after instrumentation with: (1) Hand instrument, (2) Ultrasonic scaler, and (3) Hand instrument + Diode laser application.

Materials and Methods: A total of 30 extracted non-carious non-restored human teeth with a history of periodontal disease were randomly divided into three groups of 10 teeth each and subjected to scaling and root planing with the assigned instrument. Scanning electron micrographs were taken and interpreted by a blind investigator, the indices used for this study were: Remaining calculus index, loss of tooth substance index (LTSI), and roughness LTSI. The data obtained were analyzed using Kruskal–Wallis test.

Results: No statistically significant differences were found between the three groups with respect to the efficacy of calculus removal and the iatrogenic effects caused by the instruments. However, the efficacy of ultrasonic scaler was marginally better, whereas the roughness caused after laser application was more when compared with the other groups.

Conclusion: The results of this study show that all three instruments could be used for routine debridement of the root surfaces. Ultrasonic scalers were found to be more efficient than hand scalers. The result also suggests that the diode laser may be routinely used as an adjunct to scaling and root planing as the surface alterations caused were minimal.

Key Words: Diode laser, Gracey curette, root planing, scaling, scanning electron microscopy, ultrasonic scalers

Introduction
Periodontal disease is a mixed infection primarily caused by periodontal pathogens existing within the subgingival plaque.¹ Diverse bacteria exist in the subgingival plaque, forming an extremely complicated bacterial flora.² Periodontal bacteria form a biofilm in the periodontal pocket and directly or indirectly cause damage to the periodontium by producing or inducing the production of various kinds of enzymes and exotoxins.³ This biofilm formed is complex, with bacterial extracellular polymeric substances,⁴ and its construction is so dense that antimicrobial agents can barely penetrate to its full depth. As a result, biofilm infections are usually difficult to treat with antibiotics and should be mechanically disrupted. Therefore, the major focus of conventional periodontal therapy is mechanical debridement of bacterial plaque and bacterial products from the root surfaces and periodontal pockets.⁵

Instrumentation of the tooth surface is an important part of periodontal therapy. The smoothest root possible should be the goal of root planing. Although the rugosity of the root surface has only a minimal effect on the healing of the periodontal apparatus, it may facilitate further bacterial accumulation and subsequent calculus deposition.⁶ Scaling and root planing are traditionally used to restore gingival health by removing plaque, calculus, and endotoxins which cause inflammation and periodontal disease. Hand and ultrasonic scalers are common instruments used for debridement of root surfaces as a part of routine periodontal therapy. With the advent of lasers in dentistry, the combination of laser application along with conventional therapy has become very popular. The beam of laser light is capable of completing scaling and root planing and achieving a delicate curettage, preventing dentine hypersensitivity, and sterilizing the gingival sulcus.⁷
amount of remaining calculus present, the roughness of root surface caused, and the loss of tooth substance caused after instrumentation with hand instruments, ultrasonic scaler, and hand instrument + diode laser.

**Materials and Methods**

The study was designed as a 3 group non-randomized *in vitro* experimental study. The study was conducted on 30 extracted single-rooted teeth. The selection criteria for the extracted tooth included the following:

1. Teeth extracted due to severe periodontal disease,
2. No previous history of professional periodontal therapy for the past 6 months,
3. Teeth with intact root surfaces,
4. The absence of any caries or restorations.

After extraction, the teeth were cleansed in running tap water and any adherent soft tissue on the tooth surface was removed using a scaler. The teeth were then fixed in 10% formaldehyde solution for 24-48 h. The 30 selected teeth were randomly divided into three groups of 10 teeth each. The proximal surface (mesial) of each tooth was chosen to receive treatment, as follows:

Group I: Hand instrumentation with Gracey curette No. 1/2 (Hu-Friedy Co., Chicago, IL, US)

Group II: Instrumentation with a Piezoelectric ultrasonic scaling unit (EMS SA, München, Germany). A subgingival PS ultrasonic tip was used under profuse rinsing with water spray at a medium power setting.

Group III: Hand instrumentation with Gracey curette No. 1/2 (Hu-Friedy Co., Chicago, IL, US) followed by laser application using a diode laser device (AMD laser US) with a wavelength of 980 nm and an energy of 2 W of power was applied with pulse repetition (100-ms pulse and stop of 50) the 2-mm-diameter tip was focused and in non-contact mode along with continuous isotonic normal saline for cooling to avoid any undesired changes in temperature.

A single operator competent in scaling and root planing performed all the instrumentations. The specimens were observed under a scanning electron microscope (SEM) (JEOL JSM 840A, operating at 15 kV). The SEM were scored blindly by an investigator. The amount of remaining calculus, roughness, and loss of tooth substances were recorded using the following indices:

- **Remaining calculus index**
  
  0=No calculus remaining on the root surface
  
  1=Small patches of extraneous material, probably consisting of calculus
  
  2=Definite patches of calculus confined to smaller areas
  
  3=Considerable amount of remaining calculus, appearing as one or a few voluminous patches or as several smaller patches scattered on the treated surface.

- **Loss of tooth substance index (LTSI)**
  
  0=No detectable loss of tooth substance
  
  1=Slight loss of tooth substance restricted to localized areas; most of the cementum intact
  
  2=Definite loss of tooth substance on most of the treated surface but without deep instrumental marks in the dentin; cementum may be absent in some areas
  
  3=Considerable loss of tooth substance with deep instrumental marks in the dentin; most of the cementum is removed.

- **Roughness loss of tooth substance index (RLTSI)**
  
  0=Smooth or even root surface, without marks from the instrumentation and with no loss of tooth substance
  
  1=Slightly roughened or corrugated local areas confined to the cementum
  
  2=Definitely corrugated local areas where the cementum may be completely removed, although most of the cementum is still present
  
  3=Considerable loss of tooth substance, with instrumentation marks extending into the dentin. The cementum is completely removed in large areas, or there are a considerable number of lesions due to the instrumentation.

**Results**

RCI, LTSI, and RLTSI were analyzed and are presented as median, range, and mean rank. The difference between the 3 instruments in these outcome variables was measured for statistical significance using Kruskal–Wallis test (Tables 1-3).

**Discussion**

Scaling and root planing are routine measures used in the treatment of periodontal diseases. In this study, all the procedures were performed by the main investigator to
eliminate the interoperator inconstancy and to minimize variations in factors such as stroke length, force, and pressure applied during instrumentation. Evaluation of the amount of remaining calculus, loss of tooth substance, and roughness were based on visual examination of SEM, and the scoring was done according to the defined criteria.

The results of the present study show that hand instrumentation showed higher loss of tooth substance when compared to the ultrasonic scaler, but the results were not statistically significant (Figures 1 and 2). Vastardis et al. in his study did not observe any marked change with regard to the defect depth between these two forms of root instrumentation. However, studies by Kawashima et al. showed Piezoelectric scalers removed less root substance when compared with curettes.

Several studies have proposed that hand instruments produce a significantly smoother root surface than ultrasonic scalers, whereas other studies have suggested that an ultrasonic scaler produced a smoother root surface than hand instrument. In this study, the root surfaces treated with ultrasonic instrumentation showed a surface texture concurrent with hand instrumentation; there was no statistically significant difference in the roughness produced on the tooth surface between the three groups. This study concedes with the findings by Stendhe et al., who reported that the root surface of teeth was left smooth and basically unaltered by ultrasonic instrumentation and are merely identical with the two types of instrumentation.

The results of the present study clearly indicate that both hand and ultrasonic instruments considerably reduce calculus deposits on the root surfaces which is in accordance with the previous studies. Both ultrasonic and manual instrumentation removed calculus quite effectively in this study, but the difference in efficacy was not statistically significant. The results also indicate that additional application of diode laser had no effect on calculus removal.

The teeth were scaled and root planed in all the three groups, and additional application of laser was done in the 3rd group. The 3rd group showed an increase in roughness of the root surface, but this observation was not statistically significant when compared with the other groups (Figure 3). Studies by Kreisler et al. indicated that application of laser for pocket decontamination in periodontal therapy may cause damage to hard tissue when blood is present. However, this being an in vitro study could not look into that issue. Schwarz et al. in his study had shown that laser itself was not suitable for calculus removal and altered the root surface in an undesirable manner. However, in the present study, laser irradiation was done after conventional scaling and root planing and surface alterations caused were minimal. The results of our study uphold the fact the instrumentation with hand and ultrasonic instruments did not have any statistically significant differences on the root surface when the parameters of roughness and loss of tooth substance were compared. Application of diode laser did not produce any adverse effects in our study. The findings of
this study upheld the fact that diode laser can be used as adjunct to scaling and root planing to minimize collateral effects of dentine hypersensitivity. The results of this study suggest that conventional scaling and root planing with hand and ultrasonic scalers did produce the desired results with minimal iatrogenic effects. The results also confirm the fact that diode laser can be used as an adjunct in treating periodontal patients along with conventional scaling and root planing.

**Conclusion**
The findings of the present study suggest that all the three methods were effective in mechanical debridement of the root surface. Ultrasonic scaler had a marginal advantage in all the three parameters compared in the study. Further, in vivo studies with a larger sample size may be needed to establish the effectiveness of these instruments.

**References**