Comparative evaluation of hand and power-driven instruments on root surface characteristics: A scanning electron microscopy study

PARVEEN DAHIYA, REET KAMAL1, RAJAN GUPTA, NYMPHEA PANDIT2

Abstract

Aim: The aim of this study was to compare root surface characteristics following root planing with various hand- and power-driven instruments. Materials and Methods: A total of 20 single, rooted teeth were used in this study; two specimens were used as control (no instrumentation done) and the remaining 18 specimens were equally divided into three groups. Specimens from each group were then subjected to root planing by one of the following instruments: (1) a Gracey curette, (2) ultrasonic tip and (3) a Rotary bur. In each case, the time required for scaling and root planing and surface roughness using the Roughness and Loss of Tooth Substance Index (RLTSI) was measured. Result: The mean RLTSI scores for the Gracey curette, ultrasonic and rotary instrument groups were 2.5, 2.0 and 0.667, respectively. The mean scores of time spent for scaling and root planing by the Gracey curette, ultrasonic and rotary instrument groups in seconds were 42.50, 35.83 and 54.50, respectively. Conclusions: All the three instruments, namely Gracey curette, ultrasonic tip and rotary bur, were effective in mechanical debridement of the root surface. The results favored the use of rotary instruments for root planing to achieve a smooth, clean root surface; however, the use of rotary instrument was more time consuming, which might limit its use in clinical practice.

Keywords: Gracey curette, periodontal disease, root planing, scaling, ultrasonic tip

Introduction

Instrumentation of the tooth surface is an important part of periodontal therapy. The periodic removal of accumulated material from the teeth and preparing the root surface by root planing is essential for controlling periodontal disease. Since long, the hand instruments were the first choice of clinicians. It was believed that these instruments produced a smooth root surface, but considerable manual dexterity is required for their effective operation. Moreover, hand instruments are more time consuming and are unable to reach the deeper root surface, where pockets are more than 4 mm deep.

Ultrasonic instruments were originally designed for gross scaling and removal of supragingival calculus and stains. More recently, these power-driven instruments have been modified to have smaller diameter tips and longer working lengths, thereby providing better access to deep probing sites and more efficient subgingival instrumentation. Ultrasonic instruments are simple to use, but it is often difficult to achieve smooth and calculus-free root surface. To overcome the challenges associated with the use of ultrasonic and hand scalers, rotary instruments for scaling and root planing have been developed. These are found to be more effective in root furrows, furcation areas and root surfaces in deep, narrow infra bony pockets.

It has now been well documented that all the hand- and power-driven instruments cause some gouging and removal of tooth substance. This could have an important clinical implication keeping in view the problems of hypersensitivity and roughness of root surface. Hence, the present study aimed to evaluate root surface characteristics following treatment with hand- and power-driven instruments.

Materials and Methods

The teeth selected for the study were extracted from patients that reported to the outpatient department of Oral and Maxillofacial Surgery of Sh. J.N. Kapoor D.A.V. (C) Dental College and Hospital, Yamuna Nagar, Haryana (India). Teeth that had undergone a root canal treatment, any periapical lesion, caries and history of scaling and root planing in previous 6 months were excluded from the study.

Collection and storage of teeth

Twenty single rooted human teeth, extracted due to severe
chronic periodontitis having hopeless prognosis with bone loss >70% and grade III mobility, were used in this study. The teeth were then washed with distilled water and treated with 2% sodium hypochlorite solution and then stored in normal saline until further study.

**Preparation of teeth**
Two specimens were used as control and the remaining 18 specimens were equally divided in three groups.
- **Group I** Specimens treated with hand instruments
- **Group II** Specimens treated with ultrasonic instruments
- **Group III** Specimens treated with rotary instruments

**Control**
The specimens of the control group were thoroughly cleaned and washed using toothbrush only.

**Hand instruments**
1-2 and 3-4 Gracey curettes (Hu-Friedy Chicago, IL, USA) were used for instrumentation. Strokes were given on the proximal surface along the long axis of the root.

**Ultrasonic instrument**
Instrumentation was performed with a Piezo-electric ultrasonic scaling unit (EMS SA, München, Germany). A subgingival PS ultrasonic tip was used according to the manufacturer’s instruction under profuse rinsing with water spray at a medium power setting. Unidirectional strokes were given on the proximal surface along the long axis of the teeth.

**Rotary instruments**
Rotary instruments were used with a contraangle hand piece of micromotor for root instrumentation. These rotary burs for root planing [Desmoclean (Hager, Germany)] were used at 8000 rpm with light pressure and water spraying. Unidirectional strokes were given on the proximal surface along the long axis of the teeth.

After instrumentation, specimens were prepared for scanning electron microscopy (SEM) study.

Measurement of time required for scaling and root planing
The length of time was measured with a stopwatch from start until the root surface appeared smooth upon visual inspection and examination with an explorer.

**Determination of root surface roughness**
The SEM photomicrographs at $\times100$ and $\times500$ were scored blindly and independently by two investigators using Roughness and Loss of Tooth Substance Index (RLTISI)$^5$ [Table 1]. To eliminate bias, the study was designed such that the person who evaluated roughness was unaware of the procedure used.

**Roughness and Loss of Tooth Substance Index**
1. Smooth and even root surface without marks from instrumentation and with no loss of tooth substance.
2. Slightly roughened and corrugated local areas confined to the cementum.
3. Definitely corrugated local areas where cementum may be completely removed, although most of the cementum is still present.
4. Considerable loss of tooth substance with instrumentation marks into the dentin. The cementum is completely removed in large areas or it has a considerable number of lesions from the instrumentation.

**Results**

**Measurement of surface roughness**
The mean roughness scores for the Gracey curette, ultrasonic and rotary instrument groups were 2.5, 2.0 and 0.667, respectively [Table 2]. Results were significant when the rotary instrument group was compared with the Gracey curette and ultrasonic groups. However, non-significant differences were found while comparing the Gracey curette and the ultrasonic group.

**Measurement of time spent for scaling and root planing of the test surface**
The time required for treatment using a rotary instrument was

| Specimen | Group I | Group II | Group III |
|----------|---------|----------|-----------|
|          | 1st examiner | 2nd examiner | 1st examiner | 2nd examiner | 1st examiner | 2nd examiner |
| 1        | 2        | 2        | 2        | 2          | 0          | 1          |
| 2        | 2        | 3        | 2        | 3          | 0          | 0          |
| 3        | 3        | 3        | 3        | 2          | 1          | 0          |
| 4        | 2        | 2        | 2        | 2          | 1          | 1          |
| 5        | 3        | 2        | 2        | 2          | 1          | 1          |

| Groups  | No. of specimen | Total no. of score | Mean | Difference between groups |
|---------|-----------------|--------------------|------|--------------------------|
| Group I | 6               | 15                 | 2.5  | I vs. II Non-significant (P > 0.05) |
| Group II| 6               | 12                 | 2    | I vs. III Significant (P < 0.001) |
| Group III| 6              | 4                  | 0.667| II vs. III Significant (P < 0.05) |
significantly longer than that required for Gracey curette and ultrasonic instrument. The mean score for the Gracey curette, ultrasonic and rotary instrument groups were 42.50, 35.83 and 54.50 s [Table 3]. Comparison of time spent by rotary instrument group with the other two groups was significant. But, there were no significant differences in the ultrasonic and Gracey curette groups [Table 4].

**Discussion**

In the present study, the effectiveness of scaling and root planing was evaluated by an in vitro method, as an in vitro study would facilitate the selection of comparable test surface and would permit a standardization of the experimental procedures. Root surface roughness and tooth substance loss has been evaluated by measuring the size of the instrument marks,[6] by calculating the weight of the removed tooth surface,[7] by inspecting the surface under light microscope[8] and by measuring the surface roughness using a profilometer. The results of such studies have been variable and inconclusive, but the use of scanning electron microscopy can eliminate various difficulties encountered with other techniques of examining root surfaces.

Some studies reported significant differences in tooth topography with respect to type and/or sharpness of the instrument, number of strokes used and whether the tooth was moist, under copious lavage or dentifrice was used. Sharp hand curette clearly planed away considerably more accretions and dental tissue than its dull counterparts. Hand instrument often produced a haphazard, irregular pattern, particularly when vertical and horizontal strokes were combined.[9]

In the present study, microscopic examination of control specimens affected with periodontal disease showed areas of small foreign particles [Figures 1 and 2]. These small foreign bodies were deposits of calculus. Other areas on the root surface appeared amorphous and were suggestive of aggregates of microorganism or plaque. Specimens treated with Gracey curette were comparatively smoother as compared with the control specimens [Figures 3 and 4]. But, deep scratches and strae were present, representing the pathway of instrumentation and considerable loss of tooth substance during root planing. Wilkinson suggested that even a delicate hand instrument creates irregularities and scratches on the root surface, which would possibly be attributed to the microscopic roughness of the instrument’s cutting edge.[10] The mean value of score as calculated by RLTSI was 2.5. This high mean value suggested that more of tooth substance was removed by curette, which resulted in a roughened root surface.

Until relatively recently, all ultrasonic tips were large and

![Figure 1: Morphology of the root surface of the control specimen (scanning electron microscopy photograph, ×100)](image1)

![Figure 2: Morphology of the root surface of the control specimen (scanning electron microscopy photograph, ×500)](image2)

| Specimen | Group I | Group II | Group III |
|----------|---------|----------|-----------|
| 1        | 41      | 34       | 50        |
| 2        | 43      | 36       | 65        |
| 3        | 40      | 38       | 48        |
| 4        | 42      | 39       | 62        |
| 5        | 40      | 38       | 52        |
| 6        | 49      | 30       | 50        |
bulky, making them generally suitable only for supragingival or subgingival scaling, where tissue was inflamed and retractable. However, newly designed thin ultrasonic tips have allowed better access to subgingival areas previously accessible only with a hand instrument. Earlier studies using older tips designed generally showed that ultrasonic instruments left a “stippled” root surface and had a greater potential for producing root surface damage than curettes. More recent studies, especially those using the newer, thinner tips, show that ultrasonic instruments can produce root surfaces as smooth as or smoother than those that can be produced by curettes. Current evidence suggests that ultrasonic instruments used on medium power may do less damage to the root surface than hand or sonic scalers. Some studies suggested that the rotary instruments at high speed (2,00,000 revolutions per minute) and ultrasonic instruments caused more damage to the root surface when compared with hand curettes. Lie and Mayer found that diamond points with a constant speed of 3000 rpm produced the roughest surface among hand curette and ultrasonic instrument.

The specimens treated with ultrasonic instrument provided an interesting topography [Figures 5 and 6]. The instrument created an irregular surface, consisting of depression and elevations. The mean score as calculated by RLTSI was 2.0. The specimens treated with rotary instrument were flat and smooth, with no sign of gouging and scratching [Figures 7 and 8]. But, the cracks were consistently present on the surface, representing the artifact produced by dehydration during specimen processing. The mean score for RLTSI was 0.667, which represented the smooth flat and clear root surface.

Comparison of Gracey curette and ultrasonic instrument group suggested that more of tooth substance was removed by curette as compared with ultrasonic instruments. This might be because of the newer, thinner tip of the ultrasonic instrument, which caused less damage to the root surface. But, this comparison was not statistically significant ($P > 0.05$). The specimens treated with the rotary instrument produced the smoothest surface, which might be because the burs had non-cutting, elliptical, hexagonal heads.

![Figure 3: Morphology of the root surface planed with curette (scanning electron microscopy photograph, ×100)](image)

![Figure 4: Morphology of the root surface planed with curette (scanning electron microscopy photograph, ×500)](image)

![Figure 5: Morphology of the root surface planed with the ultrasonic instrument (scanning electron microscopy photograph, ×100)](image)

![Figure 6: Morphology of the root surface planed with the ultrasonic instrument (scanning electron microscopy photograph, ×500)](image)
The effectiveness of the ultrasonic instrumentation as a function of time was proved by the present study. The mean time for Gracey curette, ultrasonic instrument and rotary instrument group was 42.50, 35.83 and 54.50 s, respectively. The result showed that far more time was required by the rotary instrument than the ultrasonic and hand instruments. But, the comparison of curette and ultrasonic groups was not significant ($P > 0.01$).

Conclusions

Historically, it was generally agreed that aggressive scaling and root planing with hand instruments was necessary to remove tenacious calculus deposits and endotoxins. Based on current evidences, it is now known that endotoxicity is a weekly adherent phenomenon and hand/power-driven instruments can be used to accomplish definitive root detoxification without overinstrumentation of the root and without extensive cementum removal.

In the present study, it was proved that all the three instruments, namely curette, ultrasonic and rotary instruments, were effective in mechanical debridement of the root surface. The root surface treated with the rotary instrument appeared flat and glossy to the naked eye and SEM pictures revealed its smoothest surface. The roughness produced by the Gracey curette was found to be high, followed by ultrasonic tip and rotary bur. The time spent for scaling and root planing with rotary bur was significantly longer than the time needed for the Gracey curette and ultrasonic tip. The results favored the use of rotary instruments for root planing to achieve a smooth clean root surface. However, the use of rotary bur was more time consuming, which might limit its use in clinical practice.

References

1. Sbordone L, Ramaglia L, Gulletta E, Iacono V. Recolonization of subgingival microflora after scaling and root planing in human Periodontitis. J Periodontol 1990;61:579-84.

2. Rabbani GM, Ash MM Jr, Caffesse RG. The effectiveness of subgingival and root planing in calculus removal. J Periodontol 1981;52:119-23.

3. Moskow BS, Bressman E. Cementsal response to ultrasonic and hand instruments. J Am Dent Assoc 1972;88:698-703.

4. Rylander H, Lindhe J. Causel related periodontal therapy. In: Lindhe J, Karring T, Lang NP, editors. Clinical Periodontontology and Implant Dentistry. Copenhagen: Munksgaard; 1997. p. 432-47.

5. Lie T, Laknes KN. Evaluation of the effect on root surface of air turbine scalers and ultrasonic instrumentation. J Periodontol 1985;56:522-13.

6. Allen EF, Rhoads RH. Effect of high-speed periodontal instruments on tooth surface. J Periodontal 1963;34:352-60.

7. Elinman IA. Comparative safety of the rotosonic scaler and the curette. J Periodontol 1964;35:410-7.

8. Moskow BS, Bressmann E. Cemental Response to ultrasonic and hand instrumentation. J Am Dent Asso 1963;68:698-703.

9. Ewen S, Gwinnett AJ. A scanning electron microscopic study of teeth following periodontal instrumentation. J Periodontol 1977;48:25-6.

10. Wilkinson RF, Maybury JE. Scanning electron microscopy of the root surface following instrumentation. J Periodontol 1973;44:59-63.

11. Chen SK, Vesley D, Brosseau LM, Vincent JH. Evaluation of single use masks and respirators for protection of health care workers against mycobacterial aerosols. Am J Infect Control 1994;22:65-74.

12. Clark S, Group H, Mabler D. The effect of ultrasonic instrumentation on root surfaces. J Periodontal 1968;39:1253-32.

13. Garrett JS. Effects of non-surgical periodontal therapy on Periodontitis in humans. Areview. J Clin Periodontol 1983;10:515-21.

14. Dragoos MR. A clinical evaluation of hand and ultrasonic instruments on subgingival debridement. Part I with unmodified and modified ultrasonic inserts. Int J Periodontol 1992;12:311-7.

15. Drisco CL. Scaling and root planing without over instrumentation: Hand versus poser – driven scalers. Curr Opin Periodontol 1993;3:78-84.

16. Jacobson L, Blomlof J. Root surface texture after different scaling modalities. Scan J Dent Res 1994;102:156-60.

17. Lie T, Mayer K. Calculus removal and loss of tooth substances in response to different periodontal instruments. J Clin Periodontol 1977;4:250-62.

How to cite this article: Dahiya P, Kamal R, Gupta R, Pandit N. Comparative evaluation of hand- and power-driven instruments in root surface characteristics: A scanning electron microscopy study. Contemp Clin Dent 2011;2:79-83.

Source of Support: Nil. Conflict of Interest: None declared.