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Comparison of Subgingival Plaque Removal Using Hand Curettes, Magnetostrictive Ultrasonic Scalers and Air Polishing Devices with and without $NaHCO_3$ Abrasive Powder: An *Ex Vivo* Study

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Abstract

Background and aims. One important treatment objective of periodontal therapy is the removal of bacterial deposits and the arrest of disease progression. The aim of the present study was to compare subgingival plaque removal using hand curettes, magnetostrictive ultrasonic scalers and air-polishing devices (APD) with and without $NaHCO_3$ abrasive powder.

Materials and methods. In this controlled randomized clinical trial, all surfaces of 60 single-rooted hopeless teeth with untreated periodontitis were treated either by hand curettes, magnetostrictive ultrasonic scalers or APD with or without $NaHCO_3$ abrasive powder. The teeth were extracted and stained in methylene blue in water solution. Digital images were captured under a microscope and depth of plaque removal was measured with image processing software. ANOVA and correlation tests were applied to data.

Results. The mean comparison showed that using APD with water alone failed to achieve adequate plaque removal. Subgingival plaque removal in the lingual surface was significantly lower in all investigated instruments ($P < 0.001$). The mean cleansing depths of curettes, ultrasonic scalers and APD with $NaHCO_3$ powder were 4.6, 6.0 and 4.2 mm, respectively.

Conclusion. The effectiveness of different instruments is not identical for different sites. Therefore, the efficiency of these instruments should be adjusted for various clinical applications.

Key words: **Air polishing device (APD), curette, subgingival plaque, ultrasonic scaler.**

Introduction

Bacterial plaque is the major causative factor of inflammatory gingival and periodontal disease.[1]

Consequently, the principal objective of periodontal therapy is to eliminate this microbial flora.

Periodontal treatments are followed by maintenance procedures which control and remove microbial plaque from the tooth surface as an objective. Elimination of the subgingival microflora may be achieved mechanically either by hand, sonic and ultrasonic instrumentation or air-polishing devices (APD), which flow a powder on tooth surface with 800 km/hr air flow speed.[2] In addition to the mechanical instrumentation, other approaches for removing subgingival plaque include the use of chemical antimicrobial agents such as chlorhexidine.[2] using currets and ultrasonic instruments is time-consuming and needs intensive proficiency in addition to harming dental surfaces. APDs also have unfavorable long-term cumulative effects.[3]

Using immunoflourcent methods, it has been shown bacterial lipopolysaccaride is on the surface and not in the deeper layers of cementum.[4,5] It has been demonstrated that, using an APD, the distance between the tip of the device and teeth, air and water inflow pressure, and run time for device are factors affecting device efficiency. Application of APD after 30 s causes abrasion to the depth of 636.6 μm and this cured surface is a smooth surface and without any connective tissue attachment and fine particles such as plaque, and thus all the cementum is removed.[3,6] This is compared with the tooth substance loss after 12 movements of hand curettes and ultrasonic scalers, which were shown to be 108.9 and 11.9 μm, respectively.[7] Comparing subgingival plaque removal between old and micro ultrasonic devices, Clifford et al[8] found the efficiency of micro ultrasonic in removing apical subgingival plaque is higher in deep pockets. However, there seems to be no difference in the efficiency of scaling between hand curettes and sonic and ultrasonic instruments in single rooted teeth.[9] Studying the subgingival plaque removal on proximal root surfaces using APD with low abrasive powder on pockets between 3 to 5 mm, however, has shown this device to be more efficient than curettes.[10] It has been suggested that an efficient device removes the minimum root cementum leaving the surface smooth and free from bacterial endotoxins, and that the latter could not be achieved with ultrasonic instruments.[11]

Repeated maintenance periodontal treatments can result in the excessive removal of tooth structure and dental root surface damage. Therefore, the aim of the present study was to compare the efficiency of subgingival plaque removal with manual instruments as the gold standard, the ultrasonic instruments as a commonly used method, and the air-polishing device with or without sodium bicarbonate abrasive powder as a recently-introduced system.

Materials and Methods

This single-blind randomized clinical trial was conducted at the Department of Periodontics, Tabriz University of Medical Sciences Faculty of Dentistry, Tabriz, Iran. Sixty hopeless single-rooted teeth (20 maxillary incisors, 20 mandibular incisors and 10 mandibular first premolars) with a probing depth of 4 mm or more in at least one surface were equally selected from the left and right sides. Patients with excessive amount of subgingival plaque or debris, patients with surgery contraindication, local anesthesia, scaling contraindication or those systemic diseases such as agranulocytosis, diabetes, cardio-vascular problems, coagulation disorders, contagious disease, juvenile localized periodontitis, history of radiotherapy, chemotherapy, surgical or non-surgical periodontal treatments and teeth carrying endodontic problems, root surface caries, mentally or physically retarded patients, anxious ones and pregnant patients were excluded from the study.[3,8,9] They had signed written informed consents before registering in the study. Pocket depths, from the gingival margin to the pocket base on buccal (mesial, distal, and midbuccal), on lingual (mesial, distal, and midlingual), on mesial (buccal, lingual, and midmesial), and on distal (buccal, lingual, and middistal) were assessed and recorded. After anesthetizing in order to detect the level of gingival margin, a shallow notch has been created by round bur. Involved surfaces of each tooth were debrided randomly by one of the methods by an expert practitioner, for 5 sec. Treatment method in each tooth was selected randomly and only one method was applied to each tooth. The subgingival plaque was removed by ultrasonic instruments (12 cases), curettes (16 cases), APD with $NaHCO_3$ abrasive powder (16 cases) and APD without powder (16 cases). For this purpose, each surface was divided into three zones and the plaque was removed from the zones of 1-3:

On lingual surface:
Zone 1 = mesial
Zone 2 = mid lingual
Zone 3 = distal
On buccal surface:
Zone 1 = mesial
Zone 2 = mid buccal
Zone 3 = distal
On distal surface:
Zone 1 = buccal
Zone 2 = mid distal
Zone 3 = lingual
On mesial surface:
Zone 1 = buccal
Zone 2 = mid mesial

Zone 3 = lingual

The Gracy curettes #5-6 (which was sharpened every 10 stroke) were applied for hand instrumentation. The ultrasonic instrument (Scalex 800, American Dental Accessories, USA) with a scaler tip (Cavitron insert TFI-1000 25 kHz, Dentsply, USA) was set in medium power and water, and the user's force was minimum.[13] The APD (Prophy-Mate, NSK, Kanuma, Tochigi, Japan) was used with maximum powder (sodium bicarbonate – $NaHCO_3$ with lemon flavor, Prophy-Mate, NSK, Kanuma, Tochigi, Japan) and medium water settings.[9]

After plaque removal, teeth were extracted and irrigated under running tab water for 1 min to remove blood and unattached debris.[14] In order to separate soft connective tissue on tooth surfaces, foromocresol was used. Then, teeth were rinsed and floated in 10% methylen blue suspension for 2 min to be stained. After drying, teeth were viewed under a microscope (Leica Microsystems, Heerbrugg, Switzerland) and images were captured by a digital camera (Canon D450, Canon Inc., Osaka, Japan) with a resolution of 2136 × 2148 pixel, and analyzed using an image analysis software (Clemex Vision PE, Longueuil, Canada) in apico-coronal aspect. Laterally, the margins were set 1 mm apart from line angles of the teeth. The remaining part was also divided into three zones and the deepest plaque free zone was measured. The plaque depths from the gingival margin to the pocket base were also measured. The data were analyzed with one-way ANOVA followed by post-hoc evaluation using Tukey test. Significance level was established at 5%.(Table1)

Results

The mean pocket depth for hand instrumentation, ultrasonic instrumentation and air-abrasion with and without powder were 9.33 ± 1.35, 8.95 ± 1.33, 7.59 ± 1.65, and 9.16 ± 1.63, respectively.

The correlation test showed pocket and cleaned depths are independent variants (P = 0.0001), and factors of zone, surface and instrument have a significant effect on the cleansing depths ($F_{(3,18)} = 5.63$, $P < 0.0001$). The Tukey test (HSD [a.b]) showed in analyzing 3 zones, cleaned depth decreased from the first to third zone (depths in first, second and third zone were 3.89, 2.40, and 1.79 mm, respectively). Also, the mean comparisons of cleaned depth in four surfaces of mesial, buccal, distal and lingual showed the cleaning depth in mesial (4.04 mm), buccal (3.31 mm), distal (3.08 mm), and lingual (1.61 mm) decreased. Two surfaces including buccal and distal were in a similar group, while other surfaces were in the other group. The cleansing depths were 4.90, 3.63, 2.90 and 1.17 in ultrasonic instruments, abrasive air powder systems, hand instruments and abrasive-free air powder systems respectively, which decreased in the respective order.

Table 1. Tukey test results for different instruments in the first zone*

Groups	1	2	3
Curettes		4.66	
Ultrasonic scalers			5.91
Air-polishing device with abrasive powder		4.23	
Air-polishing device without abrasive powder	0.00		

*Zone 1: Include mesial third in buccal and lingual surfaces and buccal third in mesial and distal surfaces.

Analysis of variance showed factors of instrument and surface have a significant effect on the cleaning depths in zone 1 ($F_{(2,9)} = 20.64$, $P < 0.0001$) and this effect is consistent with their individual or in combination usage. The mean of cleaned depth in the first zone showed no difference between APD with abrasive powder and curette. Therefore, these two instruments are in one group. As shown in Table 1, cleaned depths in both are lower than ultrasonic scaler.

One-way ANOVA in the first zone and for mesial, distal, buccal, and lingual surfaces revealed the instrument type is effective on cleaning depth ($P < 0.0001$). In addition, according to Tukey test in the first zone, regarding distal and lingual surfaces, there is no difference between curettes, ultrasonic device and APD with abrasive powder (Table 2).

The comparison of instruments coefficient variations (CV) in the first zone, distal and lingual surfaces showed that APD with abrasive powder is more efficient than others (Table 3).

Also, Tukey test results in the first zone regarding buccal and mesial surfaces showed curettes and APD with abrasive powder are in the same group (Table 2). A comparison of instruments coefficient variations in zone 1 regarding buccal and mesial surfaces showed ultrasonic device is better than others (Table 3). Altogether,

Table 2. Tukey test results for different instruments in the first zone* and different surfaces

Groups	buccal			lingual		Mesial			Distal	
	1	2	3	1	2	1	2	3	1	2
Curettes		5.84			2.35		3.22			6.07
Ultrasonic scalers			7.40		2.61			7.13		6.53
Air-polishing device with abrasive powder		4.85			3.17		4.03			5.04
Air-polishing device without abrasive powder	0			0		0			0	

*Zone 1: Include mesial third in buccal and lingual surfaces and buccal third in mesial and distal surfaces.

Table 3. Coefficient of variations* for different instruments in the first zone and different surfaces**

Groups	buccal	lingual	Mesial	distal
Curettes	0.43	0.56	0.17	0.50
Ultrasonic scalers	0.13	1.050	0.12	0.32
Air- polishing device with abrasive powder	0.14	0.47	0.62	0.13
Air- polishing device without abrasive powder	—	—	—	—

*C.V = Coefficient of variation

**Zone 1: Include mesial third in buccal and lingual surfaces and buccal third in mesial and distal surfaces

Table 4. Percentage of plaque free surfaces in cleaned zone with different instruments

Groups	Surface (%)
Curettes	53.8
Ultrasonic scalers	29.3
Air-polishing device with abrasive powder	22.0
Air-polishing device without abrasive powder	00.0

*C.V = Coefficient of variation

**Zone 1: Include mesial third in buccal and lingual surfaces and buccal third in mesial and distal surfaces

curettes have the highest percent of plaque-free surfaces (Table 4).

Discussion

This study revealed that APD without abrasive powder can not remove plaque and its cleaning depth is approximately zero. This finding is in agreement with that of Petersika et al[3] On the other hand, cleaned depth in the first zone was more than the second and third zones. This finding is probably due to the importance of run time in efficiency of curettes and ultrasonic systems, since cleansing initiated from the first zone for every surface.

The mean accessible depth by curettes was 4.6 mm that is in line with the findings of Rabbani et al[12] concluding that curettes can not reach to a depth of more than 4 mm. Available depth for curettes has been reported to be 3.45 mm in another study.[8] Although, the maximum accessible depth was found to be 6 mm in distal and buccal surfaces. This difference could be due to low-depth periodontal pockets in the studies mentioned. On the other hand, our method was different from other studies. The practitioner's position and accessibility to the area has probably caused cleansed depths to be more in distal and buccal than in mesial and lingual surfaces.

Dargoo et al [13] reported the accessible depth for standard ultrasonic tip to be 3.13 mm. In the present study, this depth was 6 mm, which may reach to 7.4 mm in the buccal surface. The difference may be due to selected methodology and plaque depth or as a result of difference in ultrasonic tips used.

In this study, accessible depth for ultrasonic instrument was 0.5–1.5 mm more than curettes on average. Although ultrasonic scalers can not remove the bacterial endotoxins from root surface, [14] long-term clinical results show they are better than curettes.[15] Because ultrasonic scalers remove less tooth substance,[16] and with regard to its potential of acoustic micro streaming in removing bacteria, this instrument could be substituted for others on mesial, distal and buccal surfaces.[17,18]

Petersilka and Steinmann[19] found APD with powder can be used in 3–5 mm pockets. Despite differences in methodology, the present findings on pockets with depth of 7–8 mm are consistent with those of Petersilka & Steinmann. In addition, results indicated the highest cleaned depth with ultrasonic instrument was in buccal, mesial and distal surfaces, while with air-polishing device with abrasive powder, the highest depth was observed in the lingual surface.

The cleaned depth of lingual surface with all instruments was considerably less than that of other surfaces. This may be due to less accessibility to this zone with all instruments. Overall, the cleaned depth of lingual was less than 3 mm with all instruments. Curettes were better than ultrasonic instrument in this situation.

On the other hand, surface without plaque in cleaned zone with curettes was 53.8%. This finding does not coincide with those reported by Eberhand et al,[16] which measured cleaned zone to be 94% in pockets of 5–7 mm with run time of 2.25 min. The difference may originate from run time (5 sec in this study) and applied methodology. Further studies are suggested to focus on comparison of efficiency of different systems without a time limit.

Conclusion

Results revealed the effectiveness of different instruments is not identical for different sites. Therefore, the efficiency of these instruments should be adjusted for various clinical applications. APD without abrasive powder failed to achieve adequate plaque removal, and therefore, is not recommended for application.

References

1. Braun A, Krause F, Frentzen M, Jepsen S. Efficiency of subgingival calculus removal with the Vector-system compared to ultrasonic scaling and hand instrumentation in vitro. *J Periodontal Res* 2005;40:48-52.
2. Carvalho LH, D'Avila GB, Leão A, Gonçalves C, Haffajee AD, Socransky SS, et al. Scaling and root planing, systemic metronidazole and professional plaque removal in the treatment of chronic periodontitis in a Brazilian population II—microbiological results. *J Clin Periodontol* 2005;32:406-11.

3. Petersilka GJ, Bell M, Mehl A, Hickel R, Flemmig TF. Root defects following air polishing. *J Clin Periodontol* 2003;30:165-70.
4. Hughes FJ, Smales FC. Immunohistochemical investigation of the presence and distribution of cementum-associated lipopolysaccharides in periodontal disease. *J Periodontal Res* 1986;21:660-7.
5. Hughes FJ, Auger DW, Smales FC. Investigation of the distribution of cementum-associated lipopolysaccharides in periodontal disease by scanning electron microscope immunohistochemistry. *J Periodontal Res* 1988;23:100-6.
6. Atkinson DR, Cobb CM, Killoy WJ. The effect of an air-powder abrasive system on in vitro root surfaces. *J Periodontol* 1984;55:13-8.
7. Ritz L, Hefti AF, Rateitschak KH. An in vitro investigation on the loss of root substance in scaling with various instruments. *J Clin Periodontol* 1991;18:643-7.
8. Clifford LR, Needleman IG, Chan YK. Comparison of periodontal pocket penetration by conventional and microultrasonic inserts. *J Clin Periodontol* 1999;26:124-30.
9. Tunkel J, Heinecke A, Flemmig TF. A systematic review of efficacy of machine-driven and manual subgingival debridement in the treatment of chronic periodontitis. *J Clin Periodontol* 2002;29 Suppl 3:72-81.
10. Petersilka GJ, Tunkel J, Barakos K, Heinecke A, Häberlein I, Flemmig TF. Subgingival plaque removal at interdental sites using a low-abrasive air polishing powder. *J Periodontol* 2003;74:307-11.
11. Kishida M, Sato S, Ito K. Effects of a new ultrasonic scaler on fibroblast attachment to root surfaces: a scanning electron microscopy analysis. *J Periodontal Res* 2004;39:111-9.
12. Rabbani GM, Ash MM Jr, Caffesse RG. The effectiveness of subgingival scaling and root planing in calculus removal. *J Periodontol* 1981;52:119-23.
13. Dragoo MR, Wheeler BG. Clinical evaluation of subgingival debridement with ultrasonic instruments used by trained and untrained operators. *Gen Dent* 1996;44:234-7.
14. Zappa U, Smith B, Simona C, Graf H, Case D, Kim W. Root substance removal by scaling and root planing. *J Periodontol* 1991;62:750-4.
15. Lea SC, Landini G, Walmsley AD. Thermal imaging of ultrasonic scaler tips during tooth instrumentation. *J Clin Periodontol* 2004;31:370-5.
16. Eberhard J, Ehlers H, Falk W, Açil Y, Albers HK, Jepsen S. Efficacy of subgingival calculus removal with Er:YAG laser compared to mechanical debridement: an in situ study. *J Clin Periodontol* 2003;30:511-8.
17. Cadosch J, Zimmermann U, Ruppert M, Guindy J, Case D, Zappa U. Root surface debridement and endotoxin removal. *J Periodontal Res* 2003;38:229-36.
18. Sculean A, Schwarz F, Berakdar M, Romanos GE, Arweiler NB, Becker J. Periodontal treatment with an Er:YAG laser compared to ultrasonic instrumentation: a pilot study. *J Periodontol* 2004;75:966-73.
19. Petersilka GJ, Steinmann D, Häberlein I, Heinecke A, Flemmig TF. Subgingival plaque removal in buccal and lingual sites using a novel low abrasive air-polishing powder. *J Clin Periodontol* 2003;30:328-33.