T Arabaci
Y Çiçek
M Özgöz
V Çanakçi
CF Çanakçi
A Eltas

The comparison of the effects of three types of piezoelectric ultrasonic tips and air polishing system on the filling materials: an *in vitro* study

Authors' affiliations:
Taner Arabaci, Yasin Çiçek, Mehmet Özgöz, Varol Çanakçi, Cenk F. Çanakçi, Abubekir Eltas, Department of Periodontology, Atatürk University Faculty of Dentistry, Erzurum, Turkey

Correspondence to:
Taner Arabaci
Department of Periodontology
Atatürk University Faculty of Dentistry
Erzurum 25240
Turkey
Tel.: +90 442 2313563
Fax: +90 442 2360945
E-mail: t-arabaci@hotmail.com

Dates:
Accepted 19 June 2007

To cite this article:
Int J Dent Hygiene **5**, 2007; 205–210
Arabaci T, Çiçek Y, Özgöz M, Çanakçi V, Çanakçi CF, Eltas A. The comparison of the effects of three types of piezoelectric ultrasonic tips and air polishing system on the filling materials: an *in vitro* study.

Abstract: *Aim:* The aim of this study was to evaluate the effect of air polishing and different ultrasonic scaler inserts on dental fillings, such as amalgam, composite and porcelain. *Materials and methods:* This study was performed on amalgam, composite and porcelain samples. The surfaces of the samples were exposed to different type of piezoelectric ultrasonic scaler inserts and air-abrasive unit. The scaler inserts were Instrument A, Instrument PS and PI. The roughness of the surfaces of each sample were measured with a profilometer and observed by stereomicroscope. *Results:* The stereomicroscopic images and profilometric values showed that Instrument A and PS resulted in rough surfaces, such as chips, nicks and scratches on the amalgam, composite and porcelain surfaces. The Instrument PI roughened the amalgam surface, but it did not roughen the porcelain or composite surfaces. The profilometric measurements (Ra) showed that the roughness of the surfaces depending on air polishing was less than the ultrasonically scaled surfaces. *Conclusion:* The wrong tip applications during dental scaling procedure cause roughness, such as scratches, nicks or chips, not only on the teeth surfaces but also on the filling materials. Thus, dental scaling procedure on the restorations should be performed carefully and the roughness sites on the restorations have to be re-polished after scaling to prevent plaque accumulation.

Key words: air polishing; filling materials; plaque retention; roughness; ultrasonics

Introduction

Primer causation of the gingival diseases is plaque accumulation on teeth surfaces (1). Local factors, especially surface roughness of the dental structures such as enamel, cement and the restorative materials, are one of the aetiological factors of plaque accumulation. Surface roughness of the teeth and dental fillings can cause aesthetic and gingival problems depending on plaque retention (1–3). A rough, poorly finished surface contributes to staining, plaque accumulation and gingival irritation (4–6). So the conservative dentistry must aim to finish the restorations with a smooth and glazed surface (6). Especially, the surface roughness of facial margins of aesthetic restorations, such as composite and porcelain, are very important for aesthetics because of discolouration. However, all restorations have to be finished smoothly both on facial or lingual and interproximal sites not to cause a plaque retention area. Because the surface roughness of the restorations will cause plaque accumulation and stains, and aesthetic will be affected. Surface roughness is also important on gingiva-contacted sites. Because the roughness will cause a constant plaque accumulation, especially on proximal sites, and this cause gingival irritations.

Surface roughness and retention areas of the dental structures may be congenital or iatrogenic. Iatrogenic surface roughness may be depending on both restorative applications and periodontal scaling procedures of the teeth and the crown or filling materials. Ultrasonic debridement and air polishing are now the most effective techniques of periodontal scaling (7). But sometimes wrong applications can cause hazardous effects and defects both on the tooth surfaces and the restorations (7, 8). The defects depending on the wrong application of the ultrasonic debridement can cause scratches, gouges and nicks on the enamel or cementum (9, 10). These defects on the surface may not only cause surface roughness but also pulpitis depending on micro leaking of the microorganisms into the pulp (7).

The patients who don't consider oral hygiene have dental plaque and calculus on their teeth and restoration surfaces. So the periodontal therapy should include scaling the surface of the teeth and restorations. But this procedure must be performed without causing roughness on the scaled surfaces. Because the surface roughness is one of the important surface disorder which causes plaque accumulation.

The aim of this *in vitro* study was to compare the surface roughness of the restorations which were scaled with different piezoelectric ultrasonic tips and air polishing unit, and to guide which scaling procedure must be used on dental filling materials.

Materials and Methods

This study was performed on amalgam, composite and porcelain restoration samples. The restorations were prepared at standard conditions and were instrumented with three types of piezoelectric ultrasonic tips (Instrument A, PS and PI) (Fig. 1) and an air polishing unit (Fig. 2). Then the instrumented surfaces were examined under stereomicroscope and the roughness values were measured with a profilometer (Mitutoyo SJ: 301, Kanagava, Japan).

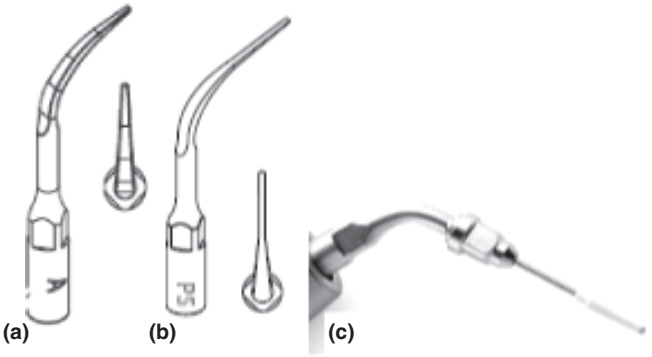

Fig. 1. (a) Instrument A; (b) Instrument PS; (c) Instrument PI.

Fig. 2. Air-abrasive device (Air flow handy).

Preparation of the amalgam samples

The amalgam materials were mixed in a Dentomat compact amalgamator (Dentomat, Guarulas, Brazil) according to the manufacturer's instructions using capsule system. The amalgam Cavex Avalloy A (Cavex Holland BV Haarlem, Netherlands) was mixed for 15 s. Each mixed amalgam materials were placed in an empty plastic cube block sized 5 mm^3 using an amalgam condenser. Then each amalgam samples were burnished with a ball burnisher and after 2 days the surfaces were polished with rubber cup.

Preparation of the composite samples

The composites were placed in rectangular plastic moulds (5 mm^3) and covered with acetate strips. A glass slide was placed over the acetate strips and pressure was applied to extrude excess material. The restoratives were light polymerized according to manufacturers' cure-times (40 s) through the glass slide with a Spectrum Curing Light.

Porcelain ceramic fabrication

Conventional porcelain ceramic VMK68 (VMK; Vident, Brea, CA, USA) were formed into approximately 15-mm-diameter × 2-mm-thick disks and the crystalline type was leucite. The firing temperature was 935°C. The porcelain powders were moistened with the recommended liquid and formed in a polyvinylsiloxane mold into compressed pellets. The disks were placed on a ceramic pillow and fired in a vacuum oven (Ultra-Mat CDF; Unitek, Monrovia, CA, USA) and then all porcelain ceramics were glazed according to manufacturers' instructions.

Surface preparation of the restorations

This study was performed by using an EMS mini piezon piezoelectric ultrasonic scaling unit (EMS CORP. USA, Greenville Ave.) and an air-abrasive unit (Air Flow handy; EMS, Nyon, Switzerland). Three types of piezoelectric ultrasonic tips were used. The piezoelectric instruments were Instrument Tip A, PS and PI (Electro Medical Systems, Nyon, Switzerland).

Each filling material samples was instrumented with each tip (Instrument A, PS and PI) under standard conditions (medium power setting, 0° angulation and standard lateral force) (Fig. 3) and air abrasion was applied at 20 psi with prophylaxis powder for 2 s (size <100 μm; Ch-1260, Nyon, Switzerland).

Fig. 3. Application of the ultrasonic tip on the samples.

Determination of surface roughness of the samples

The instrumented and air abraded surfaces of each filling material samples were observed under a stereomicroscope and the roughness of the surfaces were measured using a profilometer. The surface roughness was determined as mean roughness (Ra), defined as the average of peak and valley distances measured along the centerline of one cut-off length (11). Five measurements were performed for each sample and the mean Ra values were calculated.

Results

Profilometric results

According to the profilometric analysis (Table 1), the Ra values on each scaled filling surfaces were higher with Instrument A. The surface roughness on scaled amalgam surface was higher than the composite and porcelain surfaces with Instrument PS. In the other hand, the surface roughness on each filling sample depending on Instrument PI was less than Instrument A and PS. The Ra values on the samples depending on air-polishing unit were similar and less than these on the ultrasonically instrumented surfaces.

Stereomicroscopic observations

Amalgam samples

The stereomicroscopic examination of the instrumented amalgam surface showed that Instrument A sustained chips, scratches and loss of material on the surface (Fig. 4a). Instrument PS also roughened the amalgam surface, but loss of material on the surface was less than that of Instrument A (Fig. 4b). The stereomicroscopic images showed that Instrument PI altered the surface but it did not cause material loss (Fig. 4c). The air polished amalgam surfaces did not show macro cracks or chips under stereomicroscope (Fig. 4d).

Table 1. **Surface roughness obtained on each filling materials with different ultrasonic tip and air-polishing unit (μm)**

	Mean surface roughness values		
	Amalgam	Composite	Porcelain
Instrument A	2.73	2.01	2.12
Instrument PS	1.92	1.46	1.34
Instrument PI	0.83	0.21	0.13
Air-polishing unit	0.23	0.28	0.11

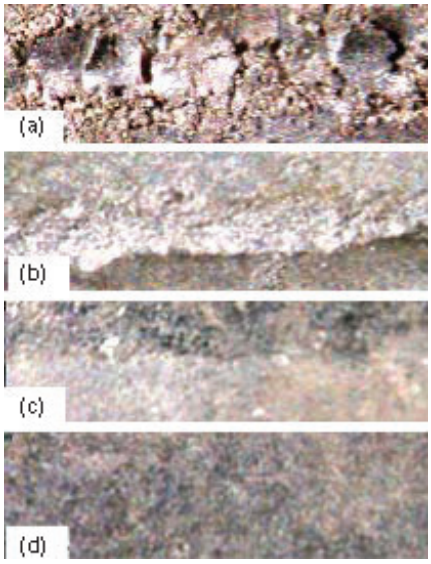

Fig. 4. (a, b, c, d) Instrumented amalgam surfaces.

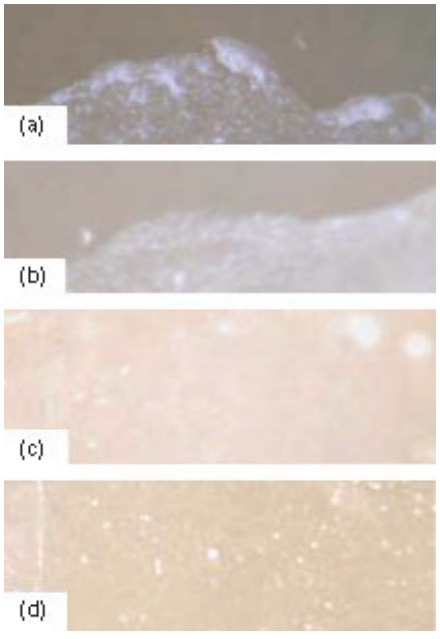

Fig. 5. (a, b, c, d) Instrumented composite surfaces.

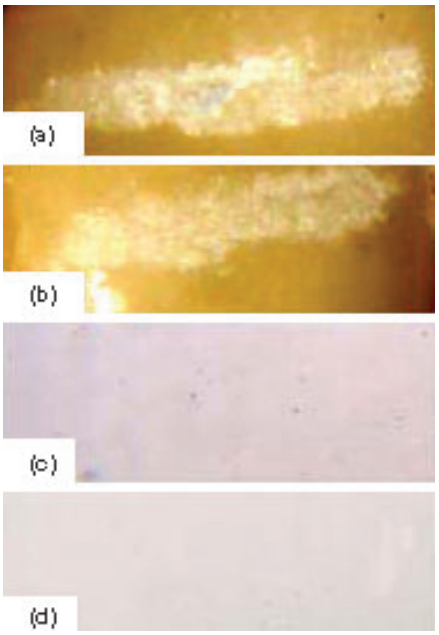

Fig. 6. (a, b, c, d) Instrumented porcelain surfaces.

Composite samples

Stereomicroscopic images showed that ultrasonic tips resulted in a roughen surface on the composites which were instrumented with Instrument A and PS (Fig. 5a and b). It was shown that Instrument PI did not roughen the surface (Fig. 5c). After air abrasive exposure, any considerable cavities or craters were not seen on the surfaces of the air-abraded composite samples (Fig. 5d).

Porcelain ceramic surfaces

The instrumented porcelain surfaces were observed under stereomicroscope and it was shown that Instrument A and Instrument PS slightly removed the glaze of the porcelain and caused pores on the surface where the tip of the inserts was stroke. But it was shown that PI and air-abrasive system did not cause any chips or pores on the surface (Fig. 6a, b, c and d).

Discussion

Gingivitis and periodontitis are primarily caused by bacterial biofilm at the interface between the hard dental surface and the soft tissue (12). The previous studies indicated that the surface roughness of the dental surfaces was found to significantly influence the establishment of dental plaque (13–15). So the surface smoothness is significant for both the enamel or root surfaces and the filling material surfaces.

Dental filling materials or restorations have to be finished with a smooth surface so as to not allow plaque retention. Because the rough surfaces which cause plaque retention reduce the oral hygiene performance of the patients. Thus, the rough surfaces can cause aesthetic problems and gingival irritations.

Furthermore, the smooth surfaces on the restorations have to be maintained during dental procedures, such as dental scaling. Dental scaling is an indispensable procedure in dental applications required for aesthetics, hygiene and gingival health. But it is reported that if the surfaces of the filling materials and crown restorations are damaged by sonic or ultrasonic scaling the power-driven scalers (sonic/ultrasonic scalers) may sustain chips, scratches or loss of material (8, 16–18). These surface disorders, such as scratches, chips or pores, on the crown restorations and dental filling materials adjacent to instrumented areas will cause plaque accumulation and stains, and also will irritate the contacted-gingiva to these restorations (4, 5).

The present study aimed to state the surface integrity and roughness of composite, amalgam and porcelain ceramic restorations depending on air polishing and piezoelectric ultrasonic instrumentation with Instrument A, PS and PI. The instrumented surfaces of the samples were examined under stereomicroscope and the images were photographed, and the surface roughness of the each scaled fillings were measured with a profilometer. The findings of the present study indicated that the scaling procedure with different type ultrasonic tips influenced the mean surface roughness of the filling materials. Folwaczny *et al.* (19) studied on root surfaces and indicated that the surface roughness was most strongly affected by the shape of the working tip and the ultrasonic device causes higher roughness on root surfaces. The stereomicroscopic images and Ra values (Table 1) showed that the amalgam surfaces were significantly affected from Instrument A and PS. The Instrument PI also altered the amalgam surface but its effect was less than other tips (Instrument A and PS). The Instrument PI only scratched the amalgam surface while the Instrument A and PS caused pores and material loss (Fig. 4 a, b and c). However, the Ra values were less for Instrument PI when comparing to Instrument A and PS. Although the studies suggested that ultrasonics could be useful for the removal of amalgam overhangs (20, 21), according to this study results this application will roughen the surface of the amalgam and will cause a plaque retention area if the surface is not re-polished after scaling. The stereomicroscopic inspection and the Ra values did not reveal a significant roughness on the surface depending on air polishing (Fig. 4d). But Türkmen *et al.* (22) examined the air abraded amalgam surfaces, at 60 psi, under SEM and they stated that extensive roughening was observed on amalgam surface and they proposed that the amalgam surface should be re-polished after air-abrasive application. The air polishing system in this study was operated at 20 psi and any significant roughness was not revealed, but nevertheless to prevent plaque retention on the amalgam surfaces, the instrumented amalgam surfaces should be re-polished after both ultrasonic and air-abrasive procedures.

The stereomicroscopic images showed that there was a roughened surface on the composite filling which were instrumented with Instrument A and PS (Fig. 5a and b), but there was no a chip or scratch on the composite surfaces which was exposed to Instrument PI and air polishing system (Fig. 5c and d), and the profilometric results confirmed the stereomicroscopic images (Table 1). The previous studies also stated that composite restorations can be significantly damaged by sonic or ultrasonic instrumentation (16–18). It is no doubt that the roughened composite surfaces will be the causation for not only aesthetic problems depending on discolouration but also gingival problems at the gingival-contacted surfaces.

The examined porcelain surfaces showed that there were pores and roughness on the instrumented surfaces with Instrument A and PS (Fig. 6a and b). But the Ra values for Instrument PI and air polishing system were less than that of Instrument A and PS and also the stereomicroscopic images did not show any chips or scratches on the glazed porcelain surfaces for Instrument PI and air polishing unit (Fig. 6c and d). Lee *et al.* (17) evaluated the changes in the surfaces of glazed porcelain after ultrasonic scaling and they stated that the roughness alterations from this procedure were not statistically significant. However, they stated that the qualitative or subjective evaluation of scanning electron micrographs and profile tracings revealed differences between glazed and instrumented porcelain surfaces. The study of Vermilyea *et al.* (16) examined porcelain labial margins after ultrasonic scaling and air polishing and they suggested that careless use of an ultrasonic scaler or air polisher could substantially alter porcelain facial margins.

Conclusion

Dental scaling is an indispensable procedure in periodontics. But the wrong applications, such as high tip angulation or power setting of ultrasonics and high air level of air polishing units, and wrong instrument choosing may damage not only the enamel surface but also the surfaces of the dental fillings or crowns. The surface damages include chips, nicks, scratches

or material loss on the surfaces may cause roughened surface and plaque retention area. It is certain that the surface roughness sustains plaque accumulation and so stains and gingival irritations in the filling-contacted gingiva. So the scaling instruments should be chosen by considering their hazardous effects on the hard surfaces not to cause a plaque accumulation area such as roughened surfaces.

References

1 Berastegui E, Canalda C, Brau E, Miquel C. Surface roughness of finished composite resins. *J Prosthet Dent* 1992; **68:** 742–749.

2 Jefferies SR, Barkmeier WW, Gwinnett AJ. Three composite finishing systems: a multisite *in vitro* evaluation. *J Esthet Dent* 1992; **4:** 181–185.

3 Tate WH, DeSchepper EJ, Cody T. Quantitative analysis of six composite polishing techniques on a hybrid composite material. *J Esthet Dent* 1992; **4:** 30–32.

4 Jefferies SR. The art and science of abrasive finishing and polishing in restorative dentistry. *Dent Clin North Am* 1998; **42:** 613–627.

5 Shintani H, Satou J, Satou N, Hayashihara H, Inoue T. Effects of various finishing methods on staining and accumulation of *Streptococcus mutans* HS-6 on composite resins. *Dent Mater* 1985; **1:** 225–227.

6 Uctaslı MB, Bala O, Gulu A. Surface roughness of flowable and packable composite resin materials after finishing with abrasive discs. *J Oral Rehabil* 2004; **31:** 1197–1202.

7 Arabacı T, Çiçek Y, Çanakçı CF. Sonic and ultrasonic scalers in periodontal treatment: a review. *Int J Dent Hygiene* 2007; **5:** 2–12.

8 American Academy of Periodontology. Sonic and ultrasonic scalers in Periodontics. *J Periodontol* 2000; **71:** 1792–1801.

9 Lie T, Leknes KN. Evaluation of the effect on root surfaces of air turbine scalers and ultrasonic instrumentation. *J Periodontol* 1985; **56:** 522–531.

10 Zappa U, Cadosch J, Simona C *et al. In vivo* scaling and root planing forces. *J Periodontol* 1991; **62:** 335–340.

11 Leitao J, Hegdahl T. On the measuring of roughness. *Acta Odontol Scand* 1981; **48:** 409–413.

12 Marsh PD, Bradshaw DJ. Dental plaque as a biofilm. *J Ind Microbiol* 1995; **15:** 169–175.

13 Leknes KN, Lie T, Wikesjö UME, Bogle GC, Selvig KA. Influence of tooth instrumentation roughness on subgingival microbial colonization. *J Periodontol* 1994; **65:** 303–308.

14 Quirynen M, Bollen CML, Papaioannou W, van Eldere J, van Steenberghe D. The influence of titanium abutment surface roughness on plaque accumulation and gingivitis: Short-term observations. *Int J Oral Maxillofac Implants* 1996; **11:** 169–178.

15 Kawai K, Urano M, Ebisu S. Effect of surface roughness of porcelain on adhesion of bacteria and their synthesizing glucans. *J Prosth Dent* 2000; **83:** 664–667.

16 Vermilyea SG, Prasanna MK, Agar JR. Effect of ultrasonic cleaning and air polishing on porcelain labial margin restorations. *J Prosthet Dent* 1994; **71:** 447–452.

17 Lee SY, Lai YL, Morgano SM. Effects of ultrasonic scaling and periodontal curettage on surface roughness of porcelain. *J Prosthet Dent* 1995; **73:** 227–232.

18 Gorfil C, Nordenberg D, Liberman R *et al.* The effect of ultrasonic cleaning and air polishing on the marginal integrity of radicular amalgam and composite resin restorations. *J Clin Periodontol* 1989; **16:** 137–139.

19 Folwaczny M, Merkel U, Mehl A, Hickel R. Influence of parameters on root surface roughness following treatment with a magnetostrictive ultrasonic scaler: An *in vitro* study. *J Periodontol* 2004; **75:** 1221–1226.

20 Blanchard JS. The periodontal curet and the ultrasonic scaler. Their effectiveness in removing overhangs from amalgam restorations. *Dent Hyg* 1984; **58:** 450–454.

21 Spinks GC, Carson RE, Hancock EB *et al.* An SEM study of overhang removal methods. *J Periodontol* 1986; **57:** 632–636.

22 Türkmen C, Sazak H, Günday M. Effects of the Nd:YAG laser, air-abrasion, and acid-etchant on filling materials. *J Oral Rehabil* 2006; **33:** 64–69.