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Received: 8 July 2021 | Accepted: 10 August 2021

DOI: 10.1111/idh.12543

International Journal of Dental Hygiene

WILEY

ORIGINAL ARTICLE

Comparison of the effects of different instrumentation techniques on root surface roughness and cement loss using micro-computerized tomography: An in-vitro study

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Funding information
None

Abstract

Objectives: The purpose of this study was to compare the effectiveness of three different instruments on the cement loss and roughness of the root surface following scaling and root planning (SRP) using micro-computerized tomography (micro-CT).

Methods: In this experimental study, 60 single-rooted extracted human teeth were used and divided into three groups. All teeth were scanned with micro-CT before and after SRP. Group 1: SRP was performed by Gracey-curette, Group 2: SRP was performed by using an ultrasonic device and Group 3: SRP was performed by using a piezo ultrasonic device. Cement loss and porosity of the root surface were analysed by micro-computerized tomography, which is a current imaging technique that provides high-quality images and allows for qualitative and quantitative analysis of samples.

Results: Results of our study revealed that initial porosity values were 1.60%, 1.25%, 1.59% for the group 1, 2, 3, and 0.93%, 0.86 and 0.80 after SRP respectively. Although Group 3 had the least surface roughness, there was no statistically significant difference between the groups. Cement loss following SRP was 47.15 μmin the piezo ultrasonic device group, 59.44 μm in the ultrasonic device, and 134.163 μm in the Gracey-curette group respectively. The highest cement loss was seen in the Gracey-curette group, and there was a significant difference between the three groups.

Conclusions: In conclusion, it was observed that surface roughness decreased and similar surface roughness was obtained with all three methods, but more cementum loss was observed with Gracey-curette. Therefore, ultrasonic devices appear to be a viable alternative to manual instrumentation with curettes.

KEYWORDS
Gracey-curette, piezo ultrasonic scaler, porosity, scaling and root planning, surface roughness, ultrasonic scaler

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1 | INTRODUCTION

Periodontitis, one of the common oral diseases in the world, is a chronic inflammatory process characterized by periodontal pocket formation and alveolar bone destruction. Early and efficient treatment of periodontitis is necessary to prevent tooth loss due to bone destruction. Bacterial plaque and calculus play a major role in the development and progression of periodontitis. The main goal of the periodontal treatment was the removal of supra and subgingival calculus and plaque deposits from tooth surfaces to prevent the progression of the disease.[1] Scaling and root planning (SRP), which target preparing a healthy and smooth root surface is the basis of the periodontal treatment.

Root topography after instrumentation significantly affects the success of the periodontal treatment. Smooth root surfaces have clinical importance such as preventing the accumulation of bacterial plaque and thus calculus formation[2] and facilitating gingival fibrous tissue reattachment.[3] Several studies on plaque accumulation have shown a positive correlation between root surface roughness and plaque growth.[4] However, it is recommended to remove as little tooth structure as possible in achieving a clean, smooth surface.[5] Because, over the years, regular substance loss through SRP can cause complications such as hypersensitivity by cumulative effect and even become a serious problem affecting the survival of the tooth.[6]

Various instruments such as hand instruments, power-driven scalers (sonic and ultrasonic scalers) and currently piezoelectric units have been used for SRP. According to some authors, hand instruments have some advantages such as obtaining decontaminate and smooth root surface with better control over the instrument.[7] However, SRP with hand instruments is time-consuming and the efficacy of treatment depends on the operator's skills[8,9] compared with power-driven instruments. It is known that effective debridement and preservation of the integrity of the tooth structure are required for a successful periodontal treatment. However, it is still unclear, which treatment model is the most effective in terms of roughness values and the loss of tooth substances.[9]

Electron microscopes, surface profilometers, optical three-dimensional (3D) laser scanners, stereoscopic microscopes have been used in studies conducted to evaluate root surface roughness until today.[10] Increasing technological innovations have led to the development of micro-computerized tomography (micro-CT), which can examine the structures on micron levels. The most important advantage of micro-CT is to be able to analyse the samples repeatedly without disruption, as well as providing high-resolution image quality.[11] It is possible to examine mineralized tissues such as teeth and bone[12] ceramics, polymers or biomaterials[13,14] directly with micro-CT.

To our knowledge, there are no previously published studies comparing surface properties with micro-CT following SRP with three different instruments. Therefore, the purpose of this study was to compare the effectiveness of three different instruments on the cement loss and roughness of the root surface following SRP using micro-CT.

2 | MATERIAL AND METHODS

This in-vitro study was approved by the Clinical Research Ethics Committee of Ankara University, Faculty of Dentistry (Approval no.:2020 14/07).

Sixty extracted single-rooted human maxillary and mandibular incisor and canine teeth (decided to be extracted due to periodontal disease) were used in this study. Before tooth extraction, detailed anamnesis including the presence of systemic disease affecting the cementum (hypothyroidism, vitamin deficiencies) was taken from the patients. The selection criteria were: the absence of dental caries; absence of root resorption; absence of any type of dental restoration and absence of systemic diseases affecting the cementum. Extracted teeth were visually inspected for the evaluation of the root surface, and teeth with excessive calculus deposition were not included in the study.

All residual soft tissue attached to the root surface was gently removed using a Gracey-curette 3/4 (Nordent). Unimportant calculus on the root surface was not removed during sample preparation. For disinfection, 5.25% NaOCl was used for 2 h, and then the teeth were stored in distilled water during the study. All samples were scanned with micro-CT before and after SRP. The presence and continuity of cement tissue was confirmed in the images of the first micro-CT scan. After the first scanning procedure, samples were randomly divided into 3 groups (n = 20 teeth per group). All teeth were instrumented by the same operator (FK) according to periodontal treatment procedures as described by Zafar et al.[15]

Group 1: SRP was performed by 15 strokes in apicocoronal direction for each surface using Gracey-curette 3/4 alone (Nordent).

Group 2: SRP was performed by 15 strokes from apical to cervical direction using linear oscillations and a frequency of 30 kHz under water cooling at medium speed using an ultrasonic device; Woodpacker UDS-J with a scaler tip 'P1' (Guilin Woodpecker Instrument Co.);

Group 3: SRP was performed by 15 strokes from apical to cervical direction using linear oscillations and a frequency of 28 kHz under water cooling at medium speed using a piezo ultrasonic device; Acteon Newtron Booster with a scaler tip 'H1' (Satalec®).

2.1 | Micro-CT evaluation

For the micro-CT evaluation of the presented study, a desktop micro-CT system (Bruker Skyscan 1275) in high resolution was used for scanning the tooth samples. The scanning properties were in the following: 100 kVp, 100-mA beam current, 0.5-mm Al/Cu filter, 10.1 μm pixel size, rotation at 0.5 step. The air calibration of the detector was performed before each scan to reduce ring artefacts. Samples were rotated 360° within an integration time of 3 m. The mean duration of scanning was approximately 120 m. Other settings included beam-hardening correction, as described, and input of optimal contrast limits according to the manufacturer's instructions, based on prior scanning and reconstruction of the samples.

Each tooth was scanned two times before and after the application of root scaling procedures to ensure standardization of the study with the same scanning parameters.

2.2 | Micro-CT image analysis

The DataViewer software (version 1.5.6.2, SkyScan, Brüker), NRecon (ver. 1.7.10.4, SkyScan) and CTAn (ver. 1.18.1.2, SkyScan) software were used for the quantitative measurements and the visualization of the samples, by using the NRecon software (Skyscan), the images obtained by the scanner were reconstructed to show two-dimensional slices of the roots. In total app. 1024 cross-sectional images were reconstructed from the whole volume. First, the reconstructed images were superimposed using DataViewer software (version 1.5.6.2, SkyScan, Brüker; Figure 1). Reference points were selected such as cusps of the teeth for superimposition of the teeth. The tooth image before the SRP procedure (reference) and the tooth image (after) SRP were superimposed, this generated a volume of subtracting image. This image represented the area and volume of the cement deformation caused by the scaling procedures (Figure 2). Moreover, The CTAn (Skyscan, Kontich, Belgium) software was used for the three-dimensional volumetric visualization, analysis, and volume of the root canal measurement. A region of interest (ROI) was drawn to include the entire specimen within the sample using CTAn software, which all specifications of the programme were used to analyse. The ROIs were starting from the lower 1/3 of the enamel and upper 1/3 of the cement (app. 1.5 x 1.5 cm) and also from the outer enamel/cement surface extending to app. 150 μm. All ROIs were cement regions, and changes in the structure could occur after root scaling techniques (Figure 3). Following parameters were calculated by CTAn (Bruker micro-CT) as; cement morphological changes (loss of cement/μm) and also porosity of the teeth.

Moreover, in this study, the porosity of the teeth was analysed from the segmented voxel images of designated ROI. The total area of porosity was calculated as the whole area of all pores (open and closed) as a percentage of the total ROI, in this case within the 1.5 x 1.5 cm ROI. The total porosity was calculated as a percentage of the overall volume using CTAn software. The reconstructed images were also further processed in Skyscan CTVox (ver. 3.3.0, SkyScan) for visualization (Skyscan).

2.3 | Statistically analysis

SPSS 17.0 (SPSS Inc.) statistical analysis programme was used to carry out data analysis in this study. The Kolmogorov–Smirnov analysis has been used to test normality assumption. According to this analysis, data did not provide normality assumption so as a non-parametric test Kruskal-Wallis H test has been used for data analysis. Statistical significance level in this study p was set to <0.05.

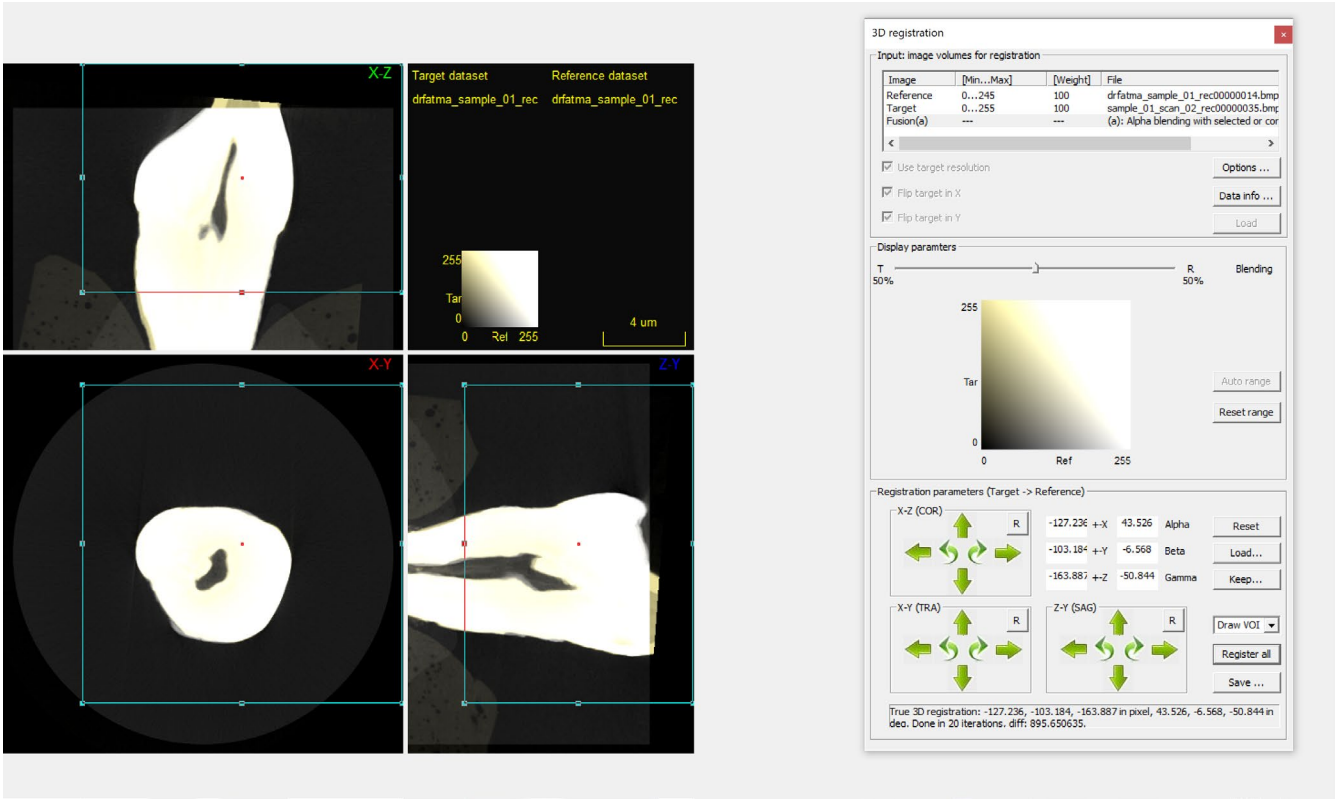


FIGURE 1 Figure showing the reconstruction and superimposition of pre- and post-scaling micro-CT images

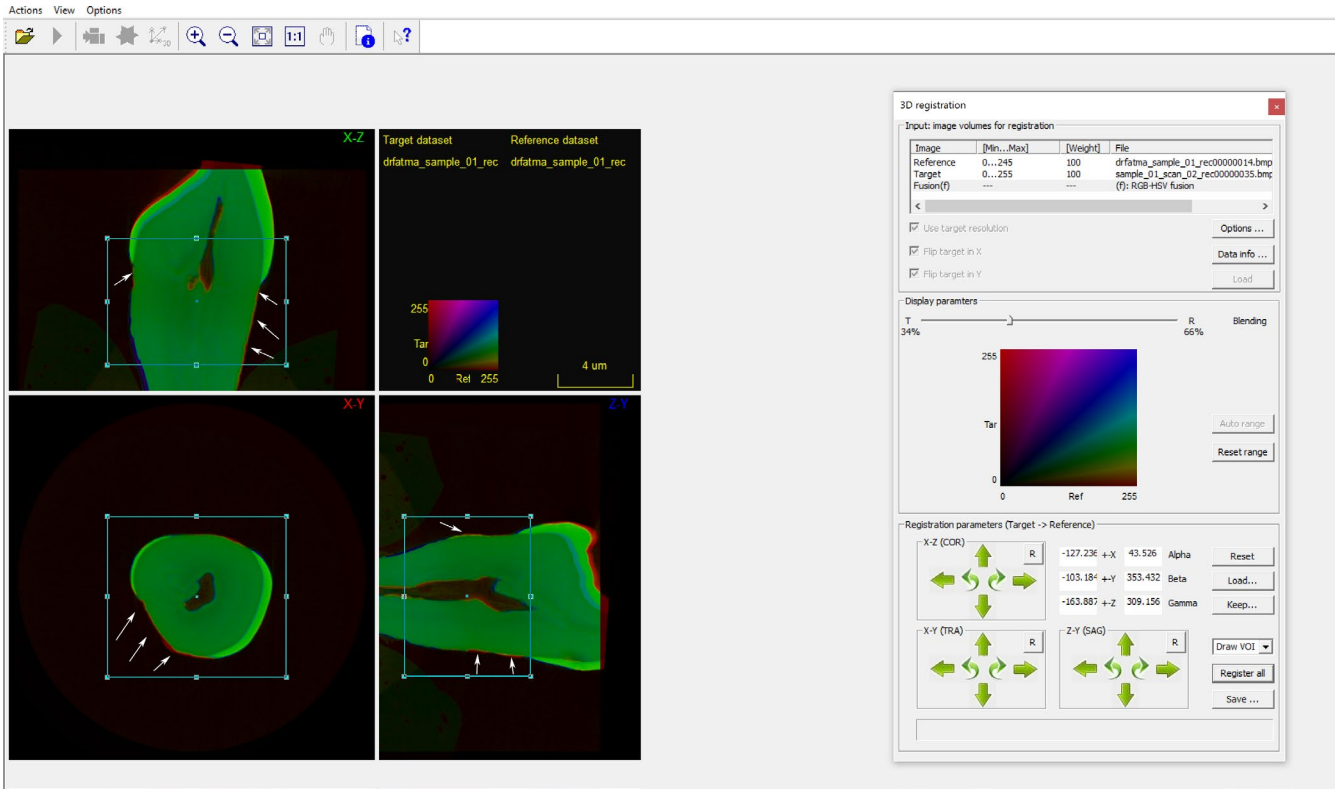


FIGURE 2 Representative images of area and volume of cement deformation after superimpostion of pre- and post-images calculated with micro-CT – in 3D. Difference of overlap of images -red areas indicate the loss

3 | RESULTS

Table 1 shows the cement loss scores (μm). The lowest cement loss was noted in the group treated with the piezo ultrasonic device (47.15 μm) whereas the cement loss was 59.44 μm in the ultrasonic device and 134.163 μm in the Gracey-curette group, respectively. The results showed a significant difference between the three groups.

Table 2 shows the mean changes in the value of surface porosity. The initial porosity values were 1.60%, 1.25%, 1.59% for the groups, respectively, and there was a significant difference between the groups. After SRP procedure these values were 0.93%, 0.86%, 0.80%, respectively. Although Group 3 had the least surface roughness, there was no statistically significant difference between the groups. Paired-group comparisons were shown a statistically significant difference between the groups after SRP. On the contrary, when the surface roughness was examined, the statistically significant difference between the groups at the beginning disappeared at the end of the SRP, and similar porosity values were found in all 3 groups (Table 3).

4 | DISCUSSION

Non-surgical periodontal therapy using hand instruments and ultrasonic scalers plays a vital role in the management of periodontal disease. However, the ideal treatment should ensure that all substances are removed from the root surfaces without any iatrogenic effect. This study aimed to compare the cement loss and the roughness on root surface morphology caused by different instruments used in non-surgical periodontal therapy. Studies have shown that the determination of the type of assessment and analysis area directly affects the results.[4,16] Most of the studies in the literature evaluated the defect depth and defect volume[17-20] caused by the applications performed with the air–dust system. There are also studies evaluating the amount of tooth tissue removed,[18,21,22] surface roughness[23-25] and scoring the smoothness and cleanliness of the surface.[26] For this purpose, SEM,[27-29] profilometry,[24,30,31] electron probe made with microanalysis device[17,32] confocal laser scanning microscope,[19] light microscope,[22,29] three-dimensional laser scanner[33,34] and micro-CT.[20]

Micro-CT analysis has started to be used because it is a non-destructive analytical method that provides objective data. Specimens can be examined both quantitatively and qualitatively; volumes can be calculated with dedicated software, whilst it is also possible to localize specific details with visual image analysis. This technology is capable of distinguishing filling materials, voids, and tooth structures with high accuracy and spatial resolution.[35]

To the best of our knowledge, there are no previously published studies comparing surface properties with micro-CT following SRP with three different instruments. Hence it was considered worthwhile to compares SRP using Micro-CT other than previous

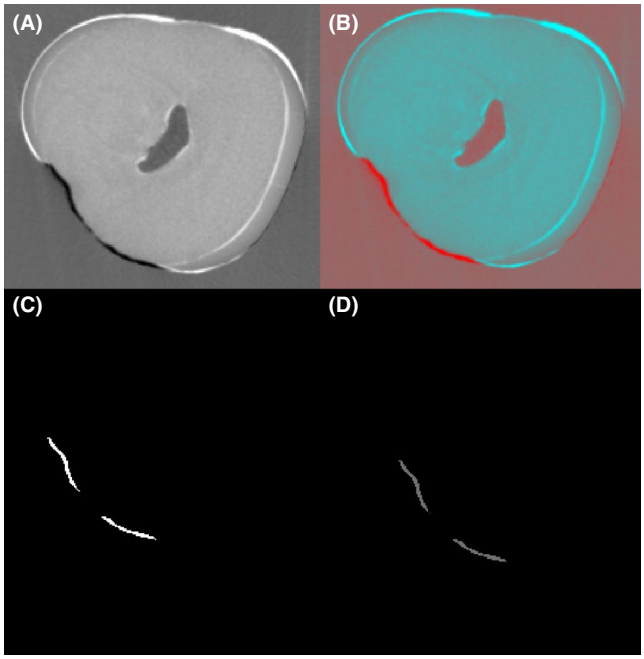


FIGURE 3 (A) Axial section of pre- and post-micro-CT, (B) Selection oF ROI-red indicates loss, (C,D). After reconstruction, the region was determined and upper/lower analysis limits were established. The cement loss areas were determined from the remaining images, and regions of interest were selected for micro-CT evaluation

TABLE 1 Cement loss scores of three groups pre- and post-SRP

	Groups	Mean loss of cement µm ± SD	Sig
Pre-SRP	Group 1	0.51 ± 1.59	0.53
	Group 2	1.65 ± 4.16	
	Group 3	1.66 ± 4.60	
Post-SRP	Group 1	134.16 ± 15.72	**0.00**
	Group 2	59.44 ± 16.19	
	Group 3	47.15 ± 11.44	

Bold value indicates p<0.05.

methodologies (profilometer, laser doppler or scanning electron microscope evaluation).

The obtained results of the current study showed that amongst the three instruments used in SRP (namely Gracey-curette, ultrasonic device and piezo ultrasonic device) the smoothest surface was obtained by the piezo ultrasonic device and the cement loss was the least in this group. However, the highest cement loss was seen in the Gracey-curette group. In various studies, a greater amount of root substance removal and morphological changes have been observed after SRP with Gracey-curette.[5,36-40] Similar to our findings, Graetz et al.[41] also reported a greater loss of root material following SRP in the Gracey-curette group. Kawashima et al.[42] also suggested that piezoelectric ultrasonic devices provide a smooth surface with minimal tooth material loss. On the contrary, Zafar et al.[15] showed

TABLE 2 Mean changes in the value of surface porosity pre- and post-SRP

	Groups	Mean surface porosity % ± SD	Sig
Pre-SRP	Group 1	1.60 ± 0.22	**0.00**
	Group 2	1.25 ± 0.24	
	Group 3	1.59 ± 0.34	
Post-SRP	Group 1	0.93 ± 2.01	0.94
	Group 2	0.86 ± 0.05	
	Group 3	0.80 ± 0.01	

Bold value indicates p<0.05.

TABLE 3 Intergroup comparison of cement loss and porosity

	Groups	Mean ± SD	Sig
Pre-SRP			
Loss of cement (µm)	Group 1–2	1.14 ± 1.17	0.59
	Group 1–3	1.14 ± 1.17	0.59
	Group 2–3	0.05 ± 1.17	1.00
Porosity (%)	Group 1–2	0.35 ± 0.08	**0.000**
	Group 1–3	0.00 ± 0.08	**0.000**
	Group 2–3	0.34 ± 0.08	**0.000**
Post-SRP			
Loss of cement(µm)	Group 1–2	74.72 ± 4.61	**0.00**
	Group 1–3	87.00 ± 4.61	**0.00**
	Group 2–3	12.28 ± 4.61	**0.02**
Porosity(%)	Group 1–2	0.07 ± 0.36	0.97
	Group 1–3	0.12 ± 0.36	0.98
	Group 2–3	0.05 ± 0.36	0.98

Bold values indicates p<0.05.

that the surface roughness is less after SRP with hand instruments. Studies reporting better surface roughness with Gracey-curettes suggested that this may be because curettes facilitate better tactile proprioception and controlled movement for the operator.[15] However, after SRP with Gracey-curettes, working strokes overlapping with sharp-edged curettes, as well as the application force applied by the practitioner, can result in greater loss of substance at the root surfaces and greater root surface roughness. On the other hand, power-driven devices require light pressure as the mechanism of action is based on both tip vibration and cavitation effect.[10]

The roughness of root surface after SRP is an important parameter, as the smooth surfaces that appear following mechanical debridement have clinical importance such as preventing bacterial plaque re-accumulation and calculus formation, facilitating gingival fibrous tissue re-adhesion.[2,3,43-45] Surface roughness decreases as the calculus and pathological cementum are removed after SRP procedures. However, the superiority of the instruments used in SRP in surface roughness is still controversial. Several studies have suggested that hand instruments are more effective in smoothing the surface than ultrasonic instruments, whereas several studies have shown the opposite. In our study, surface roughness decreased in all groups following SRP. Although the most decrease in roughness was observed in the piezo ultrasonic device group, no significant difference was found between the groups. Post-treatment surface roughness percentages after treatment were similar in all three groups.

Santos et al.[38] compared the roughness and root surface properties of teeth after SRP with a piezoelectric ultrasonic device, magnetostrictive ultrasonic device, hand tools and untreated teeth. Similar to our findings, the researchers have concluded that curettes removed more root surface material from ultrasonic devices and ultrasonic devices also created a smooth root surface. Solis Moreno et al.[46] has shown that piezoelectric devices reduce the surface roughness more than the piezo-ceramic ultrasonic scaler, curettes and finishing diamond burs. Besides, it was emphasized that the piezoelectric device provides better results, such as less damage and minimal roughness, compared to traditional ultrasonic scalers as shown in previous studies.[40,47-49] Similar results have been showing that ultrasonic instruments were superior to hand curettes[50-52]

On the contrary, several authors have reported that manual instruments leave a smoother surface compared to ultrasonic devices. Busslinger et al.[53] compared a piezoelectric scaler with a magnetostrictive scaler and a manual curette and found the highest Ra values with the piezoelectric device. The researchers concluded that the piezoelectric ultrasonic scaler was more efficient at removing calculus but leaves the tooth surface rougher than the magnetostrictive scaler and curettes. Zafar et al.[15] showed that Gracey-curettes are slightly less efficient than ultrasonic scalers in terms of surface roughness, but there is no significant difference between them. Besides, in a study conducted by scanning electron microscopy, it was suggested that in vivo root treatment with curettes or ultrasonic devices caused a similar reduction in roughness, whilst deep root grooves were produced by curettes, ultrasonic devices left a smoother surface.[38]

The evaluation methods may be responsible for the differences in the results of the available studies. Whilst arithmetic results can be obtained with profilometer, only two-dimensional information can be provided. On the other hand, SEM analysis provides non-arithmetic results about the examined sections. The advantage of the micro-CT method used in our study is that the entire scanned root surface can be evaluated with high-resolution three-dimensional images and at the same time qualitative analysis can be performed.

It is generally assumed that less-experienced operators tend to work with a higher-powered device or apply higher pressure to achieve higher efficiency,[54] thus producing more unintentional root surface damage. In our study, all SRP procedures were performed by a single experienced clinician to eliminate such factors. Besides, since the results of a recently published study[39] showed the effect of the difference in tip design on the surface roughness, we used similar tip types and power mode in ultrasonic and piezo ultrasonic devices in our study.

Aspirello et al[55] have shown that manual and ultrasonic instrumentation, both alone and in combination, causes several morphological changes on the root surface. It has been shown that combined instrumentation enables successful decontamination of root surfaces in less time than one-handed instrumentation. In this study, where we evaluated the effects of different tools used in mechanical debridement on tooth surface, the absence of a group in which hand tools and power-driven instruments were used in combination may be a limitation of our study.

The measurements in previous studies were made by referring to the non-applied surface[17,19] or by the superimposition of the images before and after the application.[20,34,56,57] It should be stated that a three-dimensional laser scanner is an imaging method that allows determining the difference between two images by overlapping the images before and after the application. However, its success is reduced when visualizing reflector surfaces such as teeth. The scattering of the laser beam on surfaces such as teeth, metal and ceramics causes a loss of resolution.[58] For this reason, it is necessary to create plaster replicas by taking silicone measurements from the samples before and after the application. In this study, the mean loss of cement, mean surface porosity was calculated, which can be an alternative method for making comparisons of effects of different instrumentation techniques on root surface.

In conclusion, within the limits of this study, it was observed that surface roughness decreased, and similar surface roughness was obtained with all three methods, but more cementum loss was observed with Gracey-curette. Therefore, ultrasonic devices appear to be a viable alternative to manual instrumentation with curettes. However, in this in-vitro study we conducted, extracted teeth were used and full simulation of the oral environment was not possible. It should not be ignored that complex oral environmental factors such as temperature, saliva and pH can also affect the functional effectiveness of the instruments. Therefore, more clinical studies are needed to address these issues.

5 | CLINICAL RELEVANCE

5.1 | Scientific role

Although various instruments have been used for SRP, it is still unclear that instrument is the most effective in terms of roughness values and the loss of tooth substances. In addition, clinicians should evaluate and follow up the clinical effects of different instruments

used with current methods. The aim of this study was to examine the effects of different instruments on the root surface morphology using micro-CT.

5.2 | Principle findings

In this study, it was observed that the highest cement loss on the root surface was observed in the Gracey-curette group, whilst root surface roughness decreased in all instruments.

5.3 | Practical implication

The results of this study show that piezo ultrasonic devices are a suitable alternative to manual instrumentation, with less cement loss and similar roughness results. Considering that SRP with hand tools is time-consuming and the effectiveness of the treatment depends on the operators' skills, piezo ultrasonic devices will offer patients more comfortable treatment with their advantages.

ACKNOWLEDGEMENTS

Authors declare that no financial support was received for this study.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTIONS

FK: Study design and instrumentation of teeth, interpretation of data and drafting of the article. KO: Micro-CT analysis of samples, interpretation of data and revision of the article. All authors contributed written and approved the final draft of the article.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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REFERENCES

1. Arabaci T, Çiçek Y, Canakçi CF. Sonic and ultrasonic scalers in periodontal treatment: a review. *Int J Dent Hyg*. 2007;5:2-12.
2. 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.
3. 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;39:111-119.
4. Kocher T, Langenbeck N, Rosin M, Bernhardt O. Methodology of three-dimensional determination of root surface roughness. *J Periodontal Res*. 2002;37:125-131.
5. 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;18:643-647.
6. Tunkel J, Heinecke A, Flemmig TF. A systematic review of the efficacy of machine-driven and manual subgingival debridement in the treatment of chronic periodontitis. *J Clin Periodontol*. 2002;29(Suppl 3), 72–81; discussion 90–1.
7. Yaghini J, Naghsh N, Attaei E, Birang R, Birang E. Root surface roughness after scaling and root planing with Er: YAG laser compared to hand and ultrasonic instruments by profilometry. *J Dent (Tehran)*. 2015;12:899-905.
8. Moghare Abed A, Tawakkoli M, Dehchenari MA, Gutknecht N, Mir M. A comparative SEM study between hand instrument and Er: YAG laser scaling and root planing. *Lasers Med Sci*. 2007;22(1):25-29.
9. Oda S, Nitta H, Setoguchi T, Izumi Y, Ishikawa I. Current concepts and advances in manual and power-driven instrumentation. *Periodontol*. 2000;2004(36):45-58.
10. Rosales-Leal JI, Flores AB, Contreras T, Bravo M, Cabrerizo-Vílchez MA, Mesa F. Effect of root planing on surface topography: an in-vivo randomized experimental trial. *J Periodontal Res*. 2015;50:205-210.
11. Kurt MH, Orhan K. Micro-computed tomography in dentistry. *Turkiye Klinikleri J Oral Maxillofac Radiol-Special Topics*. 2016;2(1):14-21.
12. Verdelis K, Salmon P. Microcomputed tomography imaging in odontogenesis studies. *Methods Mol Biol*. 2019;1922:309-324.
13. Zou W, Hunter N, Swain MV. Application of polychromatic CT for mineral density determination. *J Dent Res*. 2011;90(1):18-30.
14. Neues F, Epple M. X-ray microcomputer tomography for the study of biomineralizedendo- and exoskeletons of animals. *Chem Rev*. 2008;108(11):4734-4741.
15. Zafar MS. Comparing the effects of manual and ultrasonic instrumentation on root surface mechanical properties. *Eur J Dent*. 2016;10:517-521.
16. Casarin R, Ribeiro F, Sallum A, Sallum E, Nociti- F Jr, Casati M. Root surface defect produced by hand instruments and ultrasonic scaler with different power settings: an In Vitro Study. *Braz Dent J*. 2009;20:58-63.
17. Tada K, Kakuta K, Ogura H, Sato S. Effect of particle diameter on air polishing of dentin surfaces. *Odontology*. 2010;98(1):31-36.
18. Galloway S, Pashley DH. Rate of removal of root structure by the use of the Prophy-Jet device. *J Periodontol*. 1987;58(7):464-469.
19. Pelka M, Trautmann S, Petschelt A, Lohbauer U. Influence of air-polishing devices and abrasives on root dentin–an in vitro confocal laser scanning microscope study. *Quintessence Int*. 2010;41(7):e141-8.
20. Sahrmann P, Ronay V, Schmidlin PR, Attin T, Paqué F. Three-dimensional defect evaluation of air polishing on extracted human roots. *J Periodontol*. 2014;85(8):1107-1114.
21. Berkstein S, Reiff RL, McKinney JF, Killoy WJ. Supragingival root surface removal during maintenance procedures utilizing an air-powder abrasive system or hand scaling: an in vitro study. *J Periodontol*. 1987;58(5):327-330.
22. Horning GM, Cobb CM, Killoy WJ. Effect of an air-powder abrasive system on root surfaces in periodontal surgery. *J Clin Periodontol*. 1987;14(4):213-220.
23. Chowdhary Z, Mohan R. Efficiency of three different polishing methods on enamel and cementum: a scanning electron microscope study. *J Indian Soc Periodontol*. 2018;22(1):18.
24. Leknes KN, Lie T. Influence of polishing procedures on sonic scaling root surface roughness. *J Periodontol*. 1991;62(11):659-662.
25. Huerzeler M, Einsele F, Leupolz M, Kerkhecker U, Strub J. The effectiveness of different root debridement modalities in open flap surgery. *J Clin Periodontol*. 1998;25(3):202-208.

26. Camboni S, Donnet M. Tooth surface comparison after air polishing and rubber cup: a scanning electron microscopy study. *J Clin Dent*. 2016;27(1):13-18.
27. Barnes CM, Covey D, Watanabe H, Simetich B, Schulte JR, Chen H. An in vitro comparison of the effects of various air polishing powders on enamel and selected esthetic restorative materials. *J Clin Dent*. 2014;25(4):76-87.
28. Kontturi-Närhi V, Markkanen S, Markkanen H. Effects of airpolishing on dental plaque removal and hard tissues as evaluated by scanning electron microscopy. *J Periodontol*. 1990;61(6):334-338.
29. Atkinson DR, Cobb CM, Killoy WJ. The effect of an air-powder abrasive system on in vitro root surfaces. *J Periodontol*. 1984;55(1):13-18.
30. Bühler J, Schmidli F, Weiger R, Walter C. Analysis of the effects of air polishing powders containing sodium bicarbonate and glycine on human teeth. *Clin Oral Invest*. 2015;19(4):877-885.
31. Salami D, Luz MAAdC. Effect of prophylactic treatments on the superficial roughness of dental tissues and two esthetic restorative materials. *Pesqui Odontol Bras*. 2003;17(1):63-68.
32. Tada K, Wiroj S, Inatomi M, Sato S. The characterization of dentin defects produced by air polishing. *Odontology*. 2012;100(1):41-46.
33. Jost-Brinkmann P-G. The influence of air polishers on tooth enamel. *J Orofac Orthop*. 1998;59(1):1-16.
34. Petersilka GJ, Bell M, Mehl A, Hickel R, Flemmig TF. Root defects following air polishing: an in vitro study on the effects of working parameters. *J Clin Periodontol*. 2003;30(2):165-170.
35. Micro-computed Tomography (micro-CT) in Medicine and Engineering Editors: Orhan, Kaan (Ed.) ISBN:978-3-030-16641-0 eBook
36. Mishra MK, Prakash S. A comparative scanning electron microscopy study between hand instrument, ultrasonic scaling, and erbium-doped: Yttrium aluminum garnet laser on root surface: a morphological and thermal analysis. *Contemp Clin Dent*. 2013;4:198-205.
37. Mittal A, Nichani AS, Venugopal R, Rajani V. The effect of various ultrasonic and hand instruments on the root surfaces of human single-rooted teeth: a Planimetric and Profilometric study. *J Indian Soc Periodontol*. 2014;18:710-717.
38. Santos FA, Pochapski MT, Leal PC, Gimenes-Sakima PP, Marcantonio E Jr. Comparative study on the effect of ultrasonic instruments on the root surface in vivo. *Clin Oral Invest*. 2008;12:143-150.
39. Dahiya P, Kamal R, Gupta R, Pandit N. Comparative evaluation of hand and power-driven instruments on root surface characteristics: a scanning electron microscopy study. *Contemp Clin Dent*. 2011;2:79-83.
40. Maritato M, Orazi L, Laurito D, et al. Root surface alterations following manual and mechanical scaling: a comparative study. *Int J Dent Hygiene*. 2018;16:553-558.
41. Graetz C, Plaumann A, Wittich R, et al. Removal of simulated biofilm: an evaluation of the effect on root surfaces roughness after scaling. *Clin Oral Invest*. 2017;21:1021-1028.
42. Kawashima H, Sato S, Kishida M, Ito K. A comparison of root surface instrumentation using two piezoelectric ultrasonic scalers and a hand scaler in vivo. *J Periodontal Res*. 2007;42:90-95.
43. Aleo JJ, DeRenzis FA, Farber PA. In Vitro attachment of human gingival fibroblast to root surfaces. *J Periodontol*. 1975;46:639-645.
44. Aleo JJ, Cementum VDC. Recent concepts related to periodontal disease therapy. *Dent Clin North Am*. 1980;24:627-650.
45. Bye FL, Ghilzon RS, Caffesse RG. Root surface roughness after use of different modes of instrumentation. *Int J Periodontics Restorative Dent*. 1986;6:36-41.
46. Solís Moreno C, Santos A, Nart J, Levi P, Velásquez A, Sanz MJ. Evaluation of root surface microtopography following the use of four instrumentation systems by confocal microscopy and scanning electron microscopy: an in vitro study. *J Periodontal Res*. 2012;47:608-615.
47. Cross-Poline GN, Stach DJ, Newman SM. Effects of curette and ultrasonics on root surfaces. *Am J Dent*. 1995;8:131-133.
48. Flemmig TF, Petersilka GJ, Mehl A, Hickel R, Klaiber B. The effect of working parameters on root substance removal using a piezoelectric ultrasonic scaler in vitro. *J Clin Periodontol*. 1998;25:158-163.
49. Flemmig TF, Petersilka GJ, Mehl A, Hickel R, Klaiber B. Working parameters of a magnetostrictive ultrasonic scaler influencing root substance removal in vitro. *J Periodontol*. 1998;69:547-553.
50. Breininger DR, O'Leary TJ, Blumenshine RVH. Comparative effectiveness of ultrasonic and hand scaling for the removal of subgingival plaque and calculus. *J Periodontol*. 1987;58:9-18.
51. Copulos TA, Low SB, Walker CB, Trebilcock YY, Hefti AF. Comparative analysis between a modified ultrasonic tip and hand instruments on clinical parameters of periodontal disease. *J Periodontol*. 1993;64:694-700.
52. Drisko CL. Scaling and root planning without over instrumentation: hand versus power-driven scalers. *Curr Opin Periodontol*. 1993;3:78-88.
53. Busslinger A, Lampe K, Beuchat M, Lehmann B. A comparative in vitro study of a magnetostrictive and a piezoelectric ultrasonic scaling instrument. *J Clin Periodontol*. 2001;28:642-649.
54. König J, Ruhling A, Schlemme H, Kocher T, Schwahn C, Plagmann HC. Learning root debridement with curettes and power-driven instruments in vitro: the role of operator motivation and self-assessment. *Eur J Dent Educ*. 2002;6:169-175.
55. Aspriello SD, Piemontese M, Levrini L, Sauro S. Ultramorphology of the root surface after hand-ultrasonic simultaneous instrumentation during non-surgical periodontal treatments: an in vitro study. *J Appl Oral Sci*. 2011;19:74-81.
56. Herr ML, DeLong R, Li Y, Lunos SA, Stoltenberg JL. Use of a continual sweep motion to compare air polishing devices, powders and exposure time on unexposed root cementum. *Odontology*. 2017;105(3):311-319.
57. Petersilka GJ, Bell M, Häberlein I, Mehl A, Hickel R, Flemmig TF. In vitro evaluation of novel low abrasive air polishing powders. *J Clin Periodontol*. 2003;30(1):9-13.
58. Al Shamsi AH, Cunningham JL, Lamey PJ, Lynch E. Three-dimensional measurement of residual adhesive and enamel loss on teeth after debonding of orthodontic brackets: an in-vitro study. *Am J Orthod Dentofac Orthop*. 2007;131(3):301. e9-e15.

How to cite this article: Karacaoglu F, Orhan K. Comparison of the effects of different instrumentation techniques on root surface roughness and cement loss using micro-computerized tomography: An in-vitro study. *Int J Dent Hygiene*. 2021;00:1–8. https://doi.org/10.1111/idh.12543

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2021 Journal Performance Data for: International Journal of Dental Hygiene

ISSN
1601-5029

EISSN
1601-5037

JCR ABBREVIATION
INT J DENT HYG

ISO ABBREVIATION
Int. J. Dent. Hyg.

Journal Information

EDITION
Science Citation Index Expanded (SCIE)

CATEGORY
DENTISTRY, ORAL SURGERY & MEDICINE - SCIE

LANGUAGES
English

REGION
DENMARK

1ST ELECTRONIC JCR YEAR
2011

Publisher Information

PUBLISHER
WILEY

ADDRESS
111 RIVER ST, HOBOKEN 07030-5774, NJ

PUBLICATION FREQUENCY
4 issues/year

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