Air polishing with erythritol powder – In vitro effects on dentin loss

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**Abstract:**

**Context:** Low-abrasive polishing powders such as glycine (GLY) or erythritol (ERY) are used for subgingival air polishing. GLY was reported to possibly affect the dentin surface, while this is unclear for ERY.

**Aims:** This in vitro study aimed to evaluate the substance loss from the dentin surface by air polishing with ERY at different settings for pressure (PR), distance (DI), and angulation of the spray jet to the surface (AJ).

**Materials and Methods:** The in vitro testing was performed on smooth human root dentin surfaces. In 18 groups with 10 specimens each, ERY was applied with constant water supply for 5 s without moving the handpiece at the following settings: PR minimum (min), medium (med), and maximum (max); DI at 1, 3, and 5 mm; and 45° or 90° AJ. The substance loss was measured as defect depth (DD) using three-dimensional (3D)-laser profilometry. ANOVA with Bonferroni correction and α = 0.05 were used for statistical analysis. **Results:** The DD was statistically significantly higher at a DI of 1 mm compared to a DI of 5 mm for the respective groups of the same PR and AJ (P < 0.05). For DI 1 mm, max PR, and AJ 90°, the maximum loss of substance amounted DD of 117 ± 43 µm. **Conclusions:** Slight loss of dentin might occur during air polishing with ERY depending on DI, PR and AJ. The setting influences the amount of dentin loss.

**Key words:** Air polishing, dentin, erythritol, low-abrasive polishing powder, substance loss

**INTRODUCTION**

Many adults suffer from periodontal disease during their lifetime.[4,5] After active periodontal therapy, these patients are advised to have regular appointments for professional mechanical plaque removal (PMPR) or to participate in a program for maintenance care and supportive periodontal therapy (SPT) regularly.[4–6] PMPR or SPT is repeated two to four times a year on the basis of each patient’s individual risk of recurrence of the periodontal disease.[6] Accordingly, a compliant patient will undergo numerous sessions of PMPR or SPT throughout his or her lifetime in order to avoid any further periodontal inflammation.

As a consequence of the clinical attachment loss (CAL) due to the periodontal disease, recessions of the gingiva occur. The root surfaces are exposed and root dentin gets a supragingival position.[6] Because of the physical properties of the dentin (reduced hardness in comparison to enamel), PMPR and SPT should be performed with special attention on the exposed dentin surfaces. During PMPR and SPT procedures, supra- and subgingival mineralized and nonmineralized biofilms are removed. Here, the use of hand or oscillating instruments is widely accepted. Air polishing devices or prophylaxis brushes are preferred for nonmineralized biofilm.[7] The risk of negative side effects is inherent in the various debridement methods, as they could scratch the root surface or remove the hard-tissue substance of the root.[8,9] Frequent polishing could result in measurable amounts of substance loss, leading to further recession, dentin hypersensitivity, or cavitation.[10–12] The thin cementum layer is easily removed, when it is located supragingivally. Even worse, hard substance loss may result in cavitation, caries, pulpsitis, or apical periodontitis followed by the need for restoration or endodontic treatment. Only safe, but appropriate, methods based on individual needs should be applied during PMPR and SPT.

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Air polishing is a commonly used technique during PMPR and SPT. It was introduced more than 30 years ago in dentistry. Sodium bicarbonate powder should be used only on enamel and not directed onto an exposed root surface or into a pocket.

Low-abrasive polishing powders (LAPPs) have been developed for the supra- or subgingival application at root surfaces. LAPP are either glycine (GLY) or erythritol (ERY) based. GLY is an amino acid, whereas ERY is a sugar. Compared to sodium bicarbonate, GLY and ERY have a smaller particle size and a lower hardness on Mohs scale. LAPPs are less abrasive and water soluble. The safety of the gingival integrity has been proven. The question of potential hard substance loss of treated root surfaces was raised and not sufficiently addressed until now.

Comparative studies reported different amounts of dentin substance loss by air polishing with LAPP or sodium bicarbonate as well as other debridement methods. These studies concluded that air polishing with LAPP would be the less damaging method. It is unclear if ERY has no substance loss; only GLY has been studied in vitro. Clinically, the efficiency of LAPP for subgingival air polishing during SPT was also confirmed. In addition, subgingival air polishing also reduced the bacterial count.

Manufacturers give clear instructions for the application of air polishing. They instruct a sweep motion and an angulation of the spray jet (AJ) between 30° and 60° into the pocket or onto the tooth surface. Furthermore, only tooth areas covered with adherent plaque should be treated.

Many researchers have investigated the relevance of the parameters distance (DI), pressure (PR) of the powder or the water, and time for GLY but not for ERY. These authors confirmed that less damage of dentin surfaces would occur with increased DI, controlled power, and reduced time. These findings are based on the studies performed with GLY. To the best of our knowledge, ERY was tested only under in vitro for maintenance therapy. It is unclear if the findings obtained on material characteristics of GLY could be extended to ERY.

The aim of this in vitro study was to investigate the loss of root dentin during the application of ERY at different settings for DI, AJ, and PR. The null hypothesis is that no statistically significant differences of substance loss occur at different settings.

**MATERIALS AND METHODS**

A total of 45 human molars extracted for periodontal or endodontic reasons were collected. Consent of all patients was taken for using the tooth material in the study. The responsible ethical committee had previously approved to collect human tissue materials that would commonly be wasted during surgery when the individual patient cannot be identified by the tissue sample afterward.

First, teeth were placed in 1% chloramine-T solution before they were gently cleaned from residuals or debris, followed by storage in 3% glutaraldehyde cacadylate solution for 7 days to ensure a definitive disinfection. Thereafter, all teeth were stored in Ringer’s solution until the start of the study.

The molars were cut vertically in half by a band saw in bucal-oral direction. Both halves were fixed to specimen slides using a fast-curing composite (Technovit 4000, Heraeus Kulzer GmbH, Wehrheim, Germany), with the freshly cut surface facing the specimen slide. A total of 90 root surfaces of the 45 teeth were produced as test specimen.

Care was taken in order to position the upside surface of the root part of each sample plane, parallel to the sliding surface. Then, these surfaces were flattened and polished by a precision grinding machine (EXAKT Advanced Technologies GmbH, Norderstedt, Germany) with 4000 grit to achieve a plane surface. We chose plane specimen surfaces for this study because in previous tests, it was difficult to obtain the exact defect margin on natural root surfaces and hence it was impossible to perform accurate profilometric measurements. The average surface roughness of the dentin after the polishing was determined as 0.030 ± 0.007 µm. Furthermore, the Vickers hardness value (HV) of the root dentin of every tooth was measured (67 ± 11 HV).

The AIRFLOW® Master Piezon device (device No. 1.005.555, EMS, Nyon, Switzerland), the corresponding handpiece, and the LAPP AIRFLOW Plus (batch number 1508181, EMS) which consisted of ERY (average particle size of 14 µm and a hardness <2 on the Mohs scale) were used. The powder chamber of the device was filled with the AIRFLOW Plus powder and the weight was determined using a calibrated scale (MP 3000, Mettler Toledo, Ohio, USA) and documented. To ensure very high accuracy of the results, the powder chamber was weighed after each test run with one parameter variation and if necessary, filled again to a maximum (max) level to keep a constant PR in the chamber. During the experiment, the air PR was constantly controlled with a PR indicator and loop calibrator GE Druck DPI 802P (General Electric, Boston, Massachusetts, USA) to have 3.5 bar for maximum setting, 2.6 bar for medium (med) setting, and 1.8 bar for minimum (min) setting. The water supply was set to the maximum on the scale corresponding to a predicted water volume of about 30 ml/min.

The handpiece was clamped in an adjustable, fixed apparatus [Figure 1] to maintain standardized conditions during the trial. The apparatus allowed to direct the air–powder–water jet in an AJ of 45° or 90° onto the root surface so that the adjustments could be repeated. The specimens were placed on a height-adjustable table that was integrated into the apparatus. The nozzle tip of the handpiece was fixed at three different

| Table 1: Mean defect depths (µm) and their standard deviations for 1-5 mm distances and 45° or 90° angulations |
|---------------------------------------------------------------|
| **Mean defect depth (µm)**                                   |
| Minimum pressure     | Medium pressure     | Maximum pressure  |
| 1 mm                | 3 mm               | 5 mm               | 1 mm                | 3 mm               | 5 mm               | 1 mm                | 3 mm               | 5 mm               |
| 45°                 | 53                 | 28                 | 15                 | 50                 | 44                 | 19                 | 101                | 45                 | 26                 |
| SD                  | 23                 | 10                 | 10                 | 21                 | 24                 | 8                  | 65                 | 12                 | 16                 |
| 90°                 | 94                 | 45                 | 22                 | 155                | 61                 | 18                 | 117                | 64                 | 16                 |
| SD                  | 36                 | 11                 | 7                  | 136                | 20                 | 7                  | 43                 | 24                 | 9                  |
| SD – Standard deviation |

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DI(Rs 1, 3, and 5 mm of the air–powder–water jet, respectively) to the root surface. [Figure 2].

LAPP was blasted without movement of the handpiece onto the dentin surface for 5 s by the first investigator. A second investigator who also checked the adjustments thoroughly and labeled the treated surface area, stopped the time of the exposure.

The following different settings were evaluated:
1. Three PR settings (PR) of the air–powder–water mixture at the device: minimum (min), medium (med), and maximum (max) PR
2. Two angulations between the direction of the spray jet (AJ) between the handpiece and tip to the sample surface: 45° and 90°
3. Three DIs: 1, 3, and 5 mm.

Totally, 18 test groups with 10 specimens each were tested in random order. On each specimen, two tests could be performed on the marginal area.

Directly after the application of the powder, each sample was cleaned under flowing water and dried by dry air-blasting. The treated area was inspected under a light microscope (Axiophot, Zeiss, Jena, Germany). The air polishing treatments resulted in defects with conical shape. Yet, they differed for different angles. According to AJ [Figure 2], for 90° treatment, the base of the cones was nearly like a circle with the deepest point in the middle, whereas for the 45° treatment, the base of the cones looked elliptical, with the deepest point exocentric to the middle.

For each defect, the mean values of the maximum defect depths (DDs) along the longitudinal and transversal axes were quantified by a two-dimensional (2D) laser scanner (scanControl 2910-10/BL, Micro-Epsilon Messtechnik GmbH and Co. KG, Bavaria, Germany). The light from the diffuse-reflected laser line was detected by a receiving optical system and imaged on a high-sensitivity sensor matrix. The controller integrated inside the sensor calculates the DI information (z-axis) and the position along the laser line (x-axis) from this matrix image and outputs it in a most sensor-proof, 2D coordinate system. This allows a profile resolution of 1280 points and a dot spacing of...
Table 2: Overview of the significance values between the test groups

| DI 1 mm, min PR, 45° AJ | DI 1 mm, min PR, 90° AJ | DI 1 mm, med PR, 45° AJ | DI 1 mm, med PR, 90° AJ | DI 1 mm, max PR, 45° AJ | DI 1 mm, max PR, 90° AJ | DI 3 mm, min PR, 45° AJ | DI 3 mm, min PR, 90° AJ | DI 3 mm, med PR, 45° AJ | DI 3 mm, med PR, 90° AJ | DI 3 mm, max PR, 45° AJ | DI 3 mm, max PR, 90° AJ | DI 5 mm, min PR, 45° AJ | DI 5 mm, min PR, 90° AJ | DI 5 mm, med PR, 45° AJ | DI 5 mm, med PR, 90° AJ | DI 5 mm, max PR, 45° AJ | DI 5 mm, max PR, 90° AJ |
|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| DI 1 mm, min PR, 45° AJ | -                      | 0.007                  | 1.000                  | X                      | 0.079                  | X                      | 0.019                  | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      |
| DI 1 mm, min PR, 90° AJ | X                      | 0.424                  | X                      | 1.000                  | X                      | 0.000                  | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      |
| DI 1 mm, med PR, 45° AJ | 1.000                  | X                      | -                      | 0.035                  | 0.553                  | X                      | X                      | X                      | X                      | 1.000                  | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      |
| DI 1 mm, med PR, 90° AJ | X                      | 0.232                  | X                      | 0.019                  | X                      | 0.004                  | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      |
| DI 1 mm, max PR, 45° AJ | 0.079                  | X                      | 0.050                  | X                      | 0.007                  | 0.058                  | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      |
| DI 1 mm, max PR, 90° AJ | X                      | 1.000                  | X                      | 1.000                  | 0.553                  | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      |
| DI 3 mm, min PR, 45° AJ | 0.019                  | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      |
| DI 3 mm, min PR, 90° AJ | X                      | 0.000                  | X                      | X                      | X                      | 0.007                  | X                      | 0.302                  | X                      | 0.173                  | X                      | 0.057                  | X                      | X                      | X                      | X                      | X                      |
| DI 3 mm, med PR, 45° AJ | X                      | X                      | 1.000                  | X                      | X                      | 0.232                  | X                      | X                      | X                      | 0.141                  | 1.000                  | X                      | X                      | X                      | X                      | X                      | X                      |
| DI 3 mm, med PR, 90° AJ | X                      | X                      | 0.058                  | X                      | X                      | X                      | X                      | X                      | X                      | 0.302                  | 0.141                  | X                      | 0.797                  | X                      | X                      | X                      | X                      |
| DI 3 mm, max PR, 45° AJ | X                      | X                      | X                      | X                      | X                      | 0.027                  | X                      | X                      | X                      | X                      | X                      | 0.056                  | X                      | X                      | X                      | X                      | X                      |
| DI 3 mm, max PR, 90° AJ | X                      | X                      | X                      | X                      | X                      | X                      | X                      | 0.027                  | X                      | X                      | X                      | X                      | 1.000                  | X                      | X                      | X                      | X                      |
| DI 5 mm, min PR, 45° AJ | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | 0.344                  | X                      | x                      | 0.120                  | X                      | X                      | X                      | X                      |
| DI 5 mm, min PR, 90° AJ | X                      | X                      | X                      | X                      | X                      | 0.057                  | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      |
| DI 5 mm, med PR, 45° AJ | X                      | X                      | 0.011                  | X                      | X                      | X                      | X                      | X                      | X                      | 0.056                  | X                      | X                      | 1.000                  | X                      | X                      | X                      | X                      |
| DI 5 mm, med PR, 90° AJ | X                      | X                      | X                      | X                      | X                      | 0.004                  | X                      | X                      | X                      | 0.797                  | X                      | X                      | X                      | 0.949                  | X                      | 0.842                  | X                      |
| DI 5 mm, max PR, 45° AJ | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | X                      | 0.100                  | X                      | 0.035                  | X                      | X                      | X                      | 0.084                  | X                      |
| DI 5 mm, max PR, 90° AJ | X                      | X                      | X                      | X                      | X                      | 0.003                  | X                      | X                      | X                      | X                      | X                      | X                      | X                      | 0.019                  | X                      | X                      | X                      |

P<0.05. X – Not compared; DI – Distance; PR – Pressure; AJ – Angulation of the jet; Min – Minimal; Med – Medium; Max – Maximum.
7.8 µm. As such, it was possible to create a 2D profile detection by means of the triangulation principle. At first, the margin of the affected surface was determined from its length and width. Second, the long axis of the circle or ellipse was defined, followed by DD measurement along this longitudinal section. Third, the coordinate of the maximum horizontal width of the circle or ellipse was individually analyzed. DD was measured at this horizontal section. With this precise optical principle, the mean values of all DDs were calculated longitudinally and transversely to minimize the quota of measurement errors by incorrect determinations of the defect dimension. Furthermore, the surface roughness Rₐ within the defined surface area was assessed.

The statistical analysis for significant differences between all test groups was performed by ANOVA with Bonferroni-Dunn correction and a significance level of α = 0.05.

**RESULTS**

The results of DD are shown in Figure 3 and Table 1. The parameters DI, PR, and AJ were investigated separately and compared to each other [Table 2]. Rₐ after treatment was up to 0.352 ± 0.134 µm.

Significantly higher values for DD occurred at lower DI for all the three PRs and independently of AJ (P < 0.05) [Table 2]. DD revealed to be highest at a DI of 1 mm, AJ of 90°, and med or max PR; here the substance loss was 155 ± 36 µm or 117 ± 43 µm. As well, the highest DD was found for the combination 1 mm DI/45° AJ/max PR (101 ± 65 µm). The lowest DD values were found between 16 ± 9 µm (min PR) and 26 ± 16 µm (med PR) at a DI of 5 mm and 45° AJ.

Regarding DI 1 mm and AJ 45°, DD amounted 53 ± 23 µm at min PR and 50 ± 21 µm at med PR. Increasing DI from 1 to 5 mm resulted in a reduction of DD of about a quarter for AJ 90° and of about a third for AJ 45° within each PR setting.

PR had only a reduced impact on the differences of DD when comparing the respective groups with the same DI and AJ. Only for the groups with 1 mm DI/45° AJ and med or max PR, DD showed statistically significant differences (P < 0.05). The differences between all other compared groups were not statistically significant for PR (P > 0.05).

Regarding AJ, a tendential higher substance loss was seen for 90° in comparison to 45°. Only the groups with min PR and DI 1 and 3 mm as well as med PR and DI 1 mm differed statistically significantly (P < 0.05). For the parameter AJ, DD was 1.5 times higher, comparing the groups with the same DI and PR using 90° instead of 45°.

**DISCUSSION**

Analyzing the results, the null hypothesis had to be rejected. Our findings confirmed that air polishing with ERY results in substance loss of dentin. This loss depends on the adjustment of the parameters. Our results for ERY regarding the DD are in coincidence with the findings for GLY. When the results of the present study using ERY are compared with the literature on investigating GLY, the DDs were shown to be similar.[16,19,29,40] This was confirmed by our preliminary tests, which we performed in advance to compare ERY and GLY. The substance removals achieved were similar on both enamel and dentin.

The explanation for this substance loss is that air polishing is principally based on an abrasive process.[16,21,27] The substance loss depends not only on the particle material, size, hardness, and shape, but also on the hardness and structure of the exposed surface. It is easy to understand that air polishing using sodium bicarbonate could easily damage the dentin than enamel and could produce more substance loss than LAPP. This is widely accepted.[14,16,18] To overcome the disadvantages of sodium bicarbonate powder, other air polishing materials such as LAPP are used.[19,29,40] GLY and ERY are considered safe when used on enamel as well as on dentin surfaces.[16,18,19,21,24,27] The amount of substance loss of the dentin surface by sodium bicarbonate powder is much higher than that with LAPP.[18,19,29,40] On the other hand, also with LAPP, certain substance loss was observed.[28,40] However, all reported studies on substance loss using LAPP were performed in vitro. The results of our present study are in coincidence with these former findings. Neither positive results of clinical evaluations can be compared with in vitro outcomes,[24,32,41] nor the findings of our in vitro study can be transferred to the clinical outcome.

The results of the present study questioned that whether LAPP could generate any side effect. Our findings show the relation between the setting parameter and the substance loss, especially concerning the parameter in combination. Furthermore, it is now proven that the impact of the parameters is variable. The practitioner should respect this issue. The manufacturer gives strict instructions for the handling of air polishing to prevent unintended side effects. In detail, the tip should always be used in a constant sweeping movement. The nozzle tip should be at a DI of not less than 3 mm from the surface to treat, the spray jet should be applied with an AJ of 45°, and maximum and medium PR setting should be chosen. However, these strict manufacturer’s recommendations might not always be fulfilled during clinical use due to many reasons. Our study design aimed to evaluate the effects in a worst case scenario by combining various parameters with their various extents. Of course, the combinations of these selected parameters are in contradiction to the instructions of the manufacturer.

The substance loss caused by LAPP is not surprising because the dentin is softer than enamel and its structure with dentin tubules makes it more vulnerable. The similar findings obtained with GLY and ERY – although they are different materials – can be explained by particle size and hardness, which range in the same level for GLY and ERY.

The explanation for the absence of negative effects using LAPP in previous in vitro studies could be the single treatment procedure. In this case, the substance loss could be below the measurable level.

Furthermore, when the amount of substance loss is very low, the result of the measurement could be superimposed by the original surface roughness before the treatment as well as by the roughness caused by the treatment itself. In our study, an influence of the surface roughness on the accuracy of the measurements of the substance loss using profilometry was excluded by previous polishing of the dentin surface.
Assuming that a single treatment has a minor effect, there might be a summation effect of repeated treatments. PMFR or SPT is regularly repeated and performed many times during the life of a patient. Therefore, it is of utmost importance to choose safe cleaning methods that, despite many treatments, produce no damage over time. Our study design should simulate the summation effect of repeated treatments.

The selection of worst case scenarios and also overextending the exposure time were intentional, in order to differentiate between factors that might provoke substance loss of the root surface by air polishing. The explanation for overextending the setting is that the ability of the measuring device to detect DI differences depends on its resolution. Therefore, very little differences between the various parameters might not be detected without overextending. We thought it might be easier to observe variations performing extreme conditions. Then, their relevance could be rated in a second step.

Each factor (DI, PR, and AJ) has a different relevance regarding the amount of substance loss. DD related directly with DI as well as with AJ, whereas the effect of PR was not proportional. In literature, such influence has been described for DI and the exposure time, but the importance of AJ and PR has been underestimated so far.\cite{16,18,19} Yet, probably, AJ and PR gain higher relevance in combination with other parameters.

In our study design, the exposure time was prolonged compared to the manufacturer’s recommendations by using a fixed position of the handpiece instead of sweeping it. As a consequence, a trough was created by the spray jet instead of a groove. A sweeping motion of the tip would shorten the time of exposure of the dentin surface. Deeper defects were found, and they could be measured more accurate due to their more precise shape. However, simulating a constant sweeping movement and using a shutter to calibrate the blasting time more accurately and under constant PR are recommended for future studies.

Other factors such as the type of blasting material and the quality of the tooth material could affect the results.\cite{16,18,19,20,26,30} A critical issue is the quality of the specimen. The extracted teeth can be stored in different solutions such as formaldehyde or chloramine for disinfection. These solutions might weaken the tooth substance.\cite{42,43} For this study, the teeth were disinfected by chloramine-T and glutaraldehyde cacodylate solution, which was also accepted by other authors.\cite{42,43} Other previous studies have shown that the disinfection of the teeth did not significantly affect the obtained results.

In our study, we ensured that the HV of the used teeth was similar to the average HV of dentin. In addition, it was essential whether the original surface, the ground or cut face, was examined. The integrity of the surface was destroyed by cutting the root dentin flat. In our study, only cut faces were analyzed.

Yet, the measurement accuracy is higher using the triangulation principle on flat surfaces with a much lower roughness than that of the original surfaces. The measurement of the conical defect shape was challenging, as the tip of the cone was not necessarily located at the center of the base and the base might have the shape of an ellipse. The disadvantage of investigating not original surfaces was accepted as the preliminary tests showed that the DD could not be measured exactly on originally rounded and irregular surfaces.

Another important aspect is the effect of air polishing on clean dentin. Usually, every debridement method should be applied only if there is a bacterial biofilm or stain to be removed. It should be kept in mind that as long as the biofilm is not removed, the procedure cannot damage the tooth surface. Therefore, the manufacturer advises to stain the biofilm in order to perform air polishing only where necessary. Yet, staining of the biofilm would only be helpful supragingivally but not subgingivally. Moreover, clinically, the adhering biofilm might not always be homogeneous, so the biofilm may remain completely in some places and leak elsewhere.

In the clinical settings, it can probably not be avoided that air polishing will also affect already clean surface areas. We simulated this situation in our in vitro study by intentional air polishing of clean dentin surfaces.

It should be remembered that any mechanical manipulation of the dentin can lead to the loss of substance. Therefore, the results must be compared with the loss of substance as a result of conventional treatments such as hand curettes, ultrasonic cleaners, and polishing methods.

The amount of estimated loss of substance due to hand instruments or ultrasonic devices is estimated between 11.6 and 118.7 µm per 12 working strokes.\cite{9} Knowing this, we can say that air polishing with ERY results in very low substance loss (maximum of 155 µm) in our nonclinical overextended setting. Further investigations are needed to determine the effects in detail.

**CONCLUSIONS**

This in vitro study proves that (1) performing air polishing with ERY caused a small but measurable substance loss of the blasted dentin surfaces and (2) the amount of the substance loss varied depending on the combination of the tested parameter. It depends especially on the working DI, while the AJ and the PR setting show lower effects.

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**Conflicts of interest**

There are no conflicts of interest.

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