A randomized controlled trial on the plaque-removing efficacy of a low-abrasive air-polishing system to improve oral health care

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Objectives: While air polishing with abrasive powders has been proved efficient for sub- and supragingival application, only few studies concerning the quality of supragingival biofilm removal using the low-abrasive erythritol powder (EP) exist. The aim of the present randomized controlled trial was to clinically compare the efficacy of supragingival air polishing using EP in comparison with the rubber cup method, and to juxtapose the corresponding biofilm regrowth rates. **Method and materials:** Thirty-two young adults, suspending oral hygiene for 48 hours, were enrolled in the present double-blind short-term investigation. Using a split-mouth design, tooth polishing was conducted by means of either air polishing or rubber cups with prophylaxis paste (control). While 16 participants received air polishing in the second and fourth quadrants (and rubber cup prophylaxis in the first and third ones), the reverse sequence was applied with the remaining 16 subjects. Biofilms were assessed using the modified Quigley-Hein index (QHI), and QHI sum scores achieved both prior to and immediately after the polishing procedure, as well as 24 hours later, were assessed using a two-way analysis of variance (ANOVA), followed by Tukey's HSD to test multiple pairwise comparisons. **Results:** Both methods revealed a significant reduction of QHI scores ($P < .001$). Compared to the rubber cup method, air polishing resulted in significantly lower scores, both after tooth cleaning and after 24 hours ($P < .001$). **Conclusions:** Supragingival biofilm removal by means of air polishing combined with low-abrasive erythritol seems to be more efficacious than the traditional polishing method, and should improve oral health care. *(Quintessence Int 2021;52:752–762; doi: 10.3290/j.qi.b1763661)*

Key words: air polishing, biofilm, erythritol, low-abrasive powder, oral hygiene, plaque, professional tooth cleaning, rubber cup polishing

In recent decades, the management of dental biofilm (usually called "plaque") has continuously developed to become an important pillar of preventive dentistry. Along with the implementation of prophylactic measures in the framework of professional tooth cleaning in the dental office, biofilm removal usually is conducted by dental practitioners and/or dental hygienists.[1] During this procedure, all surfaces of the natural or restored tooth crowns are cleaned by means of hand and/or machine-driven instruments. These therapeutic approaches, however, might cause roughness,[2,3] at least to some degree. A non-polished and rough condition, in turn, will promote rapid microbial repopulation of tooth surfaces.[4,5] Recolonization of dental surfaces and permanent presence of biofilm inevitably will result in a promoted bacterial growth, thus occasionally resulting in demineralization of the tooth structure (and leading to caries in the long term),[6] along with superficial or deep inflammation of the soft tissues and alveolar bone (resulting in gingivitis and/or periodontitis).[7] Hence, to avoid rapid bacterial repopulation of the cleaned tooth surfaces, it is generally assumed that the latter should be polished after mechanical depuration.[8]

The conventional polishing method by means of a rotating rubber cup and prophylaxis paste still remains a clinical standard in many dental offices and educational institutions.[9] However, air polishing appears to represent a suitable alternative for this conventional approach, at least from a practical point of view.[10] Although air polishing has been used in dentistry for approximately 30 years,[11] this method only recently has benefitted from a growing popularity with regard to supragingival biofilm management.[9,12] While the first powders with grain sizes around 100 µm (consisting of, for example, sodium bicarbonate[13]) were characterized by high abrasiveness, thus necessitating the utilization of further polishing methods,[14] the subsequently established glycine-based abrasive powders using a smaller grain size (of approximately 25 µm) seem to allow for gentle sub- and supragingival depuration and simultaneous polishing of tooth and root surfaces.[15]

Since the introduction of low-abrasive erythritol powder (a sugar alcohol commonly used as food additive) in 2011,[16] several clinical investigations with regard to the efficacy of this material during (subgingival) periodontal treatment have been conducted, highlighting this sugar substitute as a valid alternative to conventional debridement.[17-21] So far, concerning the use of erythritol powders for supragingival biofilm removal in the course of professional tooth cleaning, only a few sporadic randomized controlled studies[22] (together with some laboratory reports[23-26]) are available from the existing literature. However, the appropriateness of erythritol's use for air polishing seems reasonable, due to average grain sizes (of approximately 14 µm) considered comparable to conventional prophylaxis pastes.[17,23] Therefore, the aim of the present double-blind randomized clinical trial was to compare the efficacy of supragingival debridement by means of air polishing (in combination with a novel low-abrasive erythritol powder) with the traditional approach (gold standard) using the established rubber cup polishing method (along with a conventional prophylaxis paste). The null hypothesis (H_0) was defined as absence of differences in specific parameters such as means (± standard deviation [SD]) of Quigley-Hein Index (QHI) sum scores for both methods achieved prior to the polishing, immediately after the polishing procedure, and 24 hours later (first possible time point to detect biofilm by means of commonly used plaque-disclosing agents).[27] H_0 was tested against the alternative hypothesis of a difference (H_A).

Method and materials

The study was categorized as a split-mouth randomized controlled trial (RCT), and was conducted according to the Helsinki Declaration of 1964 (as revised and amended in its 9th version in 2013).[28] Following the ICH-GCP-Guidelines, approval of the Federal Ethical Commission (Ethical Committee of Lower Austria, St. Pölten, Austria; GS1-EK-3/167-2020) was obtained (date of approval: 26 June 2020), followed by the registration of the present trial in the German Clinical Trial Register (DRKS00025087; 16 March 2021). All participants of this RCT gave their written informed consent for participation and use of their respective data for research purposes. Blindness of the evaluator (AF) regarding the respective treatments of the patients was assured firstly by random allocation of study participants independently and without involvement in the treatment procedure (MW); secondly, an independent assessment of treatment outcomes by a second (dispassionate) evaluator (AML) who was involved neither in the selection nor in the treatment procedure was warranted. Moreover, this impartial evaluator did not have access to any clinical information about the patients. With the present RCT focusing on improving oral health and health care, the authors adhered to the SQUIRE 2.0 statement to improve the quality, safety, and value of healthcare (http://www.squire-statement.org), and to the CONSORT statement on reporting RCTs (http://www.consort-statement.org). Figure 1 displays the corresponding study flowchart, revealing participant recruitment and flow of patients through the trial.

Sample size calculation

This study used QHI sum scores to compare two methods established for tooth cleaning; sum scores achieved immediately after the polishing procedure with either prophylaxis paste or low-abrasive erythritol powder were defined as the primary endpoints of the current study. Previous information needed to calculate a trial sample size in a prospective manner was, however, not available from the available relevant scientific reports, due to the lack of reliable data concerning the use of erythritol for supragingival air polishing at the time of study planning. Using the sample size of a similar split-mouth study showing equivalent efficacy regarding removal of supragingival plaque by the application of air polishing (sodium bicarbonate powder with the grain size of approximately 250 µm) versus conventional rubber cup polishing (Pro-Cup, Kerr) with prophylaxis paste (Cleanic, Kerr),[29] a sample size of 32 participants was considered adequate for the present investigation. Consequently,

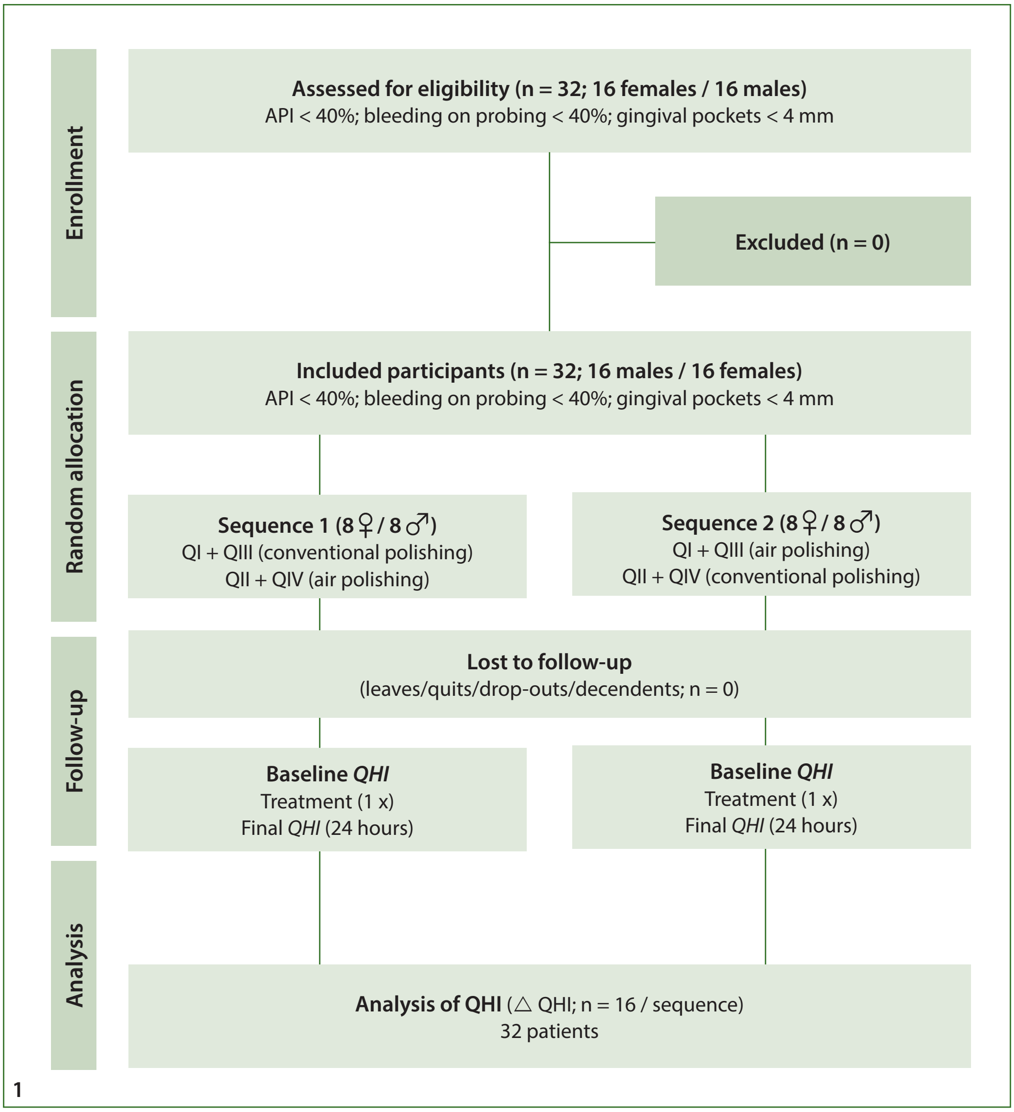

Fig 1 Graphical depiction of recruitments and flow of participants through each stage of the randomized controlled trial. Sequence 1: treatment in the first (QI) and third (QIII) quadrants (control sides) using a prophylaxis paste, treatment in the second (QII) and the fourth (QIV) quadrants (test sides) by means of air polishing. Sequence 2: treatment in the first (QI) and third (QIII) quadrants (test sides) by means of air polishing, treatment in the second (QII) and the fourth (QIV) quadrants (control sides) using a prophylaxis paste. API, Approximal Plaque Index; QHI, Quigley-Hein Index; ΔQHI, difference of QHI sum scores.

due to the lack of an appropriate prospective power calculation, a post-hoc analysis for adequate interpretation of the observed effects was scheduled, and the current investigation was initially regarded as a pilot study. Thus, the number of cases enrolled in the present study was set at 32 subjects per group, including 16 female and 16 male patients.

Recruitment of patients and randomization

All participants were regularly visiting the outpatient clinics at the Danube Private University, Krems, Austria, and requested a professional tooth cleaning. The participants were young right-handed adults; their age ranged from 18 to 30 years (mean ± SD 24.3 ± 2.9 years), with acceptable to moderate oral hygiene (dental plaque detectable in less than 40% of all interdental spaces). The level of oral hygiene was determined by means of a commonly used oral hygiene index (Approximal Plaque Index [API]),[30] combined with the determination of the oral tissue inflammation levels by means of a gingival index (Papillary Bleeding Index [PBI]).[31] In addition to the signed informed consent mentioned above, further inclusion criteria were:

- absence of systemic diseases, and no destructive periodontal diseases (no bleeding on probing > 40%; no gingival pockets > 4 mm)

- unbeknownst allergies to components of the erythritol powder (Air-Flow Plus Powder, EMS) and/or the polishing paste (Cleanic, KerrHawe).

Patients who underwent procedures of professional tooth cleaning were not allowed to use any oral hygiene items or plaque dissolving mouth rinse solutions during the 24 hours prior to the intended treatment; elsewise, they were excluded from the present investigation, due to a possible conflict with the aforementioned measures on the dyeability of dental plaque.[27]

To avoid possible bias concerning certain tooth brushing patterns typical for right-handed individuals, where the plaque removal ability in right-handed patients seems to be superior on the right side of the maxilla as well as on the left side of the mandible,[32] further allocation of study participants was needed. Therefore, participants were divided in two groups (Sequence 1 and Sequence 2), comprising equal numbers of female and male patients, followed by establishment of appropriately numbered (encoded) randomization sheets by the study principal investigator (MW), who was not involved in any further treatment procedures. The sheets included certain polishing sequences, aiming to achieve uniform distribution of polishing methods to be applied in different quadrants. With half of the randomization sheets (Sequence 1), the order to treat the first and third quadrants (control sites) using a prophylaxis paste (the second and the fourth quadrants [test sides] had to be treated by means of air polishing) was scheduled, while the other half of the sheets (Sequence 2) were assigned a reverse sequence, which was unexceptionally disclosed to the study clinical investigator (AF) prior to the respective treatments.

Clinical procedure

Among both test and control sites, all vestibular and oral tooth surfaces (except for the third molars) were covered with a bicolored plaque disclosing agent revealing both old (blue) and new (pink) plaque (Mira-2-Ton, Hager & Werken), followed by a dental plaque assessment using the Turesky-Gilmore and Glickman modification of the QHI.[33] The QHI evaluates the plaque revealed on the buccal and lingual non-restored surfaces of the teeth using a scale from 0 to 5 by dividing the total score by the number of surfaces examined. This included a grading, ranging from "0" (no plaque) to "1" (isolated spots of plaque at the gingival margin), "2" (a continuous band of plaque up to 1 mm at the gingival margin), "3" (plaque greater than 1 mm in width and covering up to one third of the tooth surface), "4" (plaque covering from one thirds to two thirds of the tooth surface), and "5" (plaque covering more than two thirds of the tooth surface). The baseline measurements were immediately recorded using a specially developed electronic data sheet (Microsoft Excel, Microsoft). Then, with the control sites, cleaning and polishing of the teeth surfaces was conducted by means of rubber cups (Pro-Cup, Kerr) and prophylaxis paste (Cleanic, Kerr), while among the test sites the surfaces were cleaned and polished with the low abrasive erythritol powder (Air-Flow Plus Powder, EMS), according to the polishing order scheduled with the randomization sequence (Fig 2).

Both the air polishing and the rubber cup approach were conducted in accordance with the manufacturer's specifications. Briefly, during the air-polishing procedure the Air-Flow Master nozzle tip (EMS) was directed to the tooth enamel, using an angle varying between 30 and 60 degrees to the gingival margin. The tip was kept at a distance of 3 to 5 mm from the tooth surface, followed by slight moves in a circular and swinging manner from the cervical tooth region toward the incisal edge. In this course, the pressure was initially set to a medium extent, to achieve effective cleaning, and then turned to a minimum load, to accelerate the polishing effect, as has been recommended recently.[34] It should be noted that the air-polishing procedure does not contain any specific manufacturer-relevant description concerning the timeframe intended for the operation; thus, polishing was carried out until the clean tooth surface (absence of any plaque disclosing agent) was visually (subjectively) evident.

Conventional polishing was initiated by means of a rotating rubber cup using a contra-angle handpiece running at a maximum speed of 3,000 rpm with a slight manual pressure; the rubber cup (Pro-Cup) was filled with the prophylaxis paste (Cleanic), and was used perpendicular to the tooth surfaces. Each portion of prophylaxis paste served to clean three adjacent teeth for approximately 10 seconds per tooth surface, followed by subsequent polishing of these surfaces for some 5 seconds with the same portion (both time periods were used as rough approximations). This procedure was consistent with the manufacturer's instructions, being based on the dynamic mechanical properties and the self-adjusting abrasiveness of perlite grains contained in the paste, allowing for both cleaning and gentle (yet powerful) polishing.[35]

After having completed cleaning and polishing of all tooth surfaces, patients rinsed the mouth with tap water to remove all polishing paste and powder residues. Subsequently, a de novo staining followed (Mira-2-Ton), and the post-treatment QHI was collected and recorded again. However, this data was assessed by the second (pre-trained and dispassionate) assis-

Fig 2 Clinical view prior to the polishing procedure with either prophylaxis paste or low-abrasive erythritol powder *(a and b)*; after the polishing procedure (AP, air polishing; RC, rubber cup) according to the Sequence 1 *(c and d)*; and after further cessation (24 hours) of oral hygiene measures *(e and f)*.

tant (AML), who was absent during the previous procedure, and, thus, was not aware of the choice of the cleaning and polishing methods in the respective quadrants (Fig 2).

Follow-up

All participants were asked to suspend any oral hygiene measures for the next 24 hours, to accumulate dental plaque for further recording.[27] At the beginning of the second appointment, each participant rinsed again with an antibacterial solution (chlorhexidine digluconate, 0.2%; GSK-Gebro Consumer Healthcare) to remove residual food debris potentially caught in interdental spaces due to the cessation of the personal oral hygiene. Then, all tooth surfaces and all quadrants were stained again (Mira-2-Ton), and QHI was re-assessed for all tooth surfaces in accordance with the aforementioned procedure (Fig 2). Finally, the stained biofilm was shown to the patient, and each participant was enabled to autonomously remove the newly formed and stained plaques using a disposable toothbrush (Happy Morning, Hager & Werken).

Statistical evaluation

Statistical analyses were performed using commercially available software (SPSS for Windows v 26.0, IBM). The evaluation was initiated by an examination of the normal distribution of data using the Kolmogorov-Smirnov test. Based on the evidence of a normal distribution, the QHI sum scores achieved prior to the polishing, immediately after the polishing procedure, and 24 hours later as well as the respective post-hoc power analysis for the present H_0 were statistically evaluated using the analysis of variance (ANOVA), combined with post-hoc Tukey HSD (honestly significant difference). After performing ANOVA, the difference between the pair of means ($M_i - M_j$) together with mean square within (MS_w) were used to calculate the HSD according to the formula HSD = ($M_i - M_j$) ÷ √(MS_w ÷ n_h), where n_h is the number of participants per treatment, following by the automatic estimation of the studentized range statistic (Q) and Tukey critical value. The level of significance was set to 5% (α = .05). Finally, a post-hoc power analysis followed, and the power (1 – β) was computed as a function of α, the effect size parameter, and the sample size used in the present study (Statistica 13.1, Dell StatSoft).

Results

The initial QHI sum scores (means ± SD) upon the first 24 hours of suspended oral hygiene (baseline) in male and female participants belonging to Sequence 1 (82.7 ± 16.3) and Sequence 2 (79.1 ± 15.4) were not statistically different (ANOVA: $P = .423$; Tukey HDS: Q = 1.65, $P = .648$). Within the test sites (air polishing combined with low-abrasive erythritol powder), the treatment led to a significant reduction (ANOVA: $P < .001$; Tukey HDS: Q = 38.92, $P < .001$) of QHI sum scores (7.1 ± 5.9) in all quadrants, followed again by significant elevations (ANOVA: $P < .001$; Tukey HDS: Q = 9.88, $P < .001$) of the QHI sum scores (25.3 ± 7.6) after further 24 hours. Similarly, with the control sites (conventional rubber cup polishing combined with prophylaxis paste), the treatment led to a significant reduction (ANOVA: $P < .001$; Tukey HDS: Q = 26.95, $P < .001$) of QHI sum scores (24.1 ± 9.5) in all quadrants, followed by a significant elevation (ANOVA: $P < .001$; Tukey HDS: Q = 7.26, $P < .001$) of QHI sum scores (39.9 ± 9.9) after a further cessation of all oral hygiene measures for 24 hours.

Notwithstanding, the air polishing combined with low-abrasive erythritol powder revealed significantly lower QHI sum scores in all test sites (ANOVA: $P < .001$, Tukey HDS: Q = 11.5, $P < .001$) compared to those of the conventional polishing approach, both immediately after the polishing procedure and after further cessation (24 hours) of oral hygiene measures. Figure 2 demonstrates the chronological trend of QHI sum scores, along with the respective plaque removal and the significantly reduced biofilm regrowth rates. The statistical power calculated retrospectively in accordance with H_0 for these latter comparisons amounted to 99% at α = .05, with an effect size for Cohen f of .41 (thus confirming the practical significance of the air-polishing approach).

Discussion

The application of airborne-particle abrasion and air polishing in dentistry is a frequently and intensively addressed topic of various scientific publications[36] having examined the use of sodium bicarbonate,[29,37] aluminum trioxide, and sodium-calcium phosphosilicate,[38] as well as glycine-based powders for both sub- and supragingival debridement.[22,39,40] The advanced erythritol powder used in the current investigation is characterized by a finer grain size compared with all aforementioned materials, and is considered to be more tissue friendly; erythritol powder consists of a non-toxic, chemically neutral and water-soluble sugar alcohol (polyol), also frequently used as a food additive.[17] Despite promising and effective clinical performances of low-abrasive erythritol powders (Air-Flow Plus Powder) regarding subgingival application,[16-18,21,41] little reliable data (except for one RCT[22] and several in vitro investigations[23-25,34]) exists concerning their efficacy for supragingival biofilm removal.

Indeed, the main intention of using the air-polishing approach would seem to eliminate dental plaque, and no true polishing effect will be achieved with this technique. Consequently, the term air polishing seems misleading (even if no considerable roughness has been observed with this technique[26]); however, alternative expressions (like air cleaning or air flowing) are endued with different meanings, and seem even more deceptive. Hence, the aim of the present prospective, randomized, clinical split-mouth study was to evaluate the efficacy of supragingival debridement by means of air polishing with low-abrasive erythritol powder (Air-Flow Plus Powder) in comparison to a conventional (gold standard) rubber cup polishing method using a prophylaxis paste (Pro-Cup and Cleanic) as control. Using a commonly used semiquantitative approach to detect the biofilm by means of the modified QHI at three different time points (prior to and immediately following the polishing procedure, as well as 24 hours later), an increased efficacy of air polishing (compared to the traditional rubber cup polishing) could be observed.

Considering the observed statistical power of 99%, the present outcome consequently led to rejection of the null hypothesis in favor of the alternative hypothesis. Moreover, termination of any proceeding with respect to the previously scheduled larger scale follow-up seems justified, since the current investigation, though initially contrived as a pilot study, was equipped with an appropriate sample size to answer the study question. Moreover, with a considerably large effect size (Cohen f ≈ .41), an indisputably clear interaction of the air-polishing method could be shown.

The results of the present study corroborate previous clinical and laboratory-based investigations concerning the higher efficiency of sub- and supragingival biofilm removal using various air-polishing devices and powders in comparison with a traditional rubber cup polishing approach.[9,10,22,23] There are

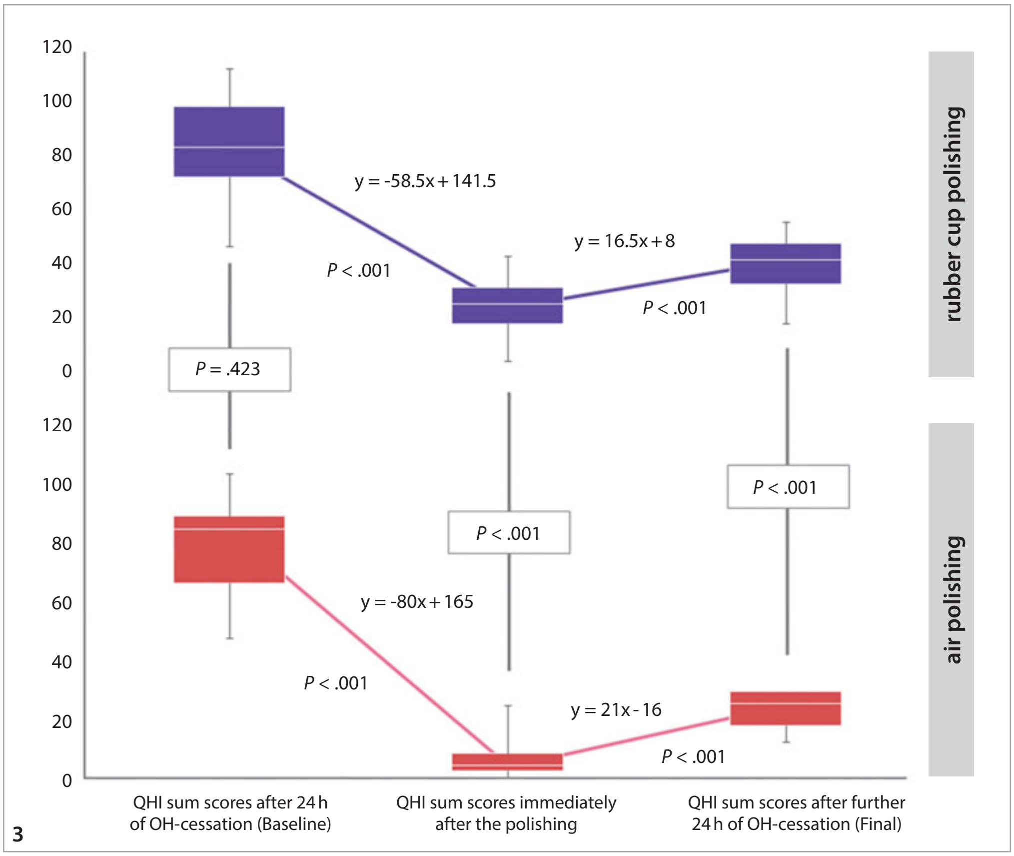

Fig 3 100%-Box-and-whisker-plots of average QHI sum scores for baseline (starting conditions after the initial cessation of oral hygiene measures for 24 hours), intermediate results (QHI sum scores immediately after the polishing), and final outcomes (after further cessation of oral hygiene measures for additional 24 hours). Slopes (gradients) of straight lines ($y = mx + b$) connecting the median values of QHI sum scores achieved at every measurement point of the experiment indicate plaque removal and biofilm regrowth rates.

several possible explanations for the superiority of the air-polishing method observed with the current clinical trial. Traditional tooth polishing represents a trivial low-abrasion process of organic deposits (and some mineralized residues, at least to some extent) on the tooth enamel surface, in fact comparable with previously conducted coarse abrasion (scaling) by means of ultrasonic tips or manual instrumentation.[12,23] However, even in combination with an abrasive polishing paste, the conventional rubber cup method is unable to reach hardly accessible surface alterations such as scratches, pits, small enamel defects, or other surface irregularities without any flattening of the tooth structure. In contrast, the air-polishing procedure, which is based on powder jet technology (applied to the tooth surface with abrasive grains), allows for almost complete depuration of deposits without any considerable flattening effects. Consequently, it seems clear that plaque regrowth will last somewhat longer on totally cleaned surfaces (if compared to those harboring any organic residues), and this seems to explain the significant differences between the QHI sum scores after cessation of oral hygiene observed in the current trial (Fig 3; and see QHI sum scores for final outcomes after further cessation of oral hygiene measures for 24 hours). Notwithstanding, the alterations on an air-polished tooth surface can indeed be labeled with the term "corrosion," meaning the scouring or sand-blasting action of wind-borne particles, and remaining abrasive in nature,[12,42] even if only gentle effects have been reported on enamel (and cementum), thus confirming the tissue-preserving of air polishing with erythritol.[26]

On the other hand, the effects of these two polishing methods decisively differ from each other, although they are based on the same principles (namely, the generation of kinetic energy).[8,12] As already has been mentioned, during air polishing the delivery and acceleration of abrasive agents (in the case of the present study low-abrasive erythritol powder grains) is achieved through aerosol, escaping from a nozzle tip with a pressure of approximately 3 to 4 bar (or 50 to 60 psi).[34] The impact forces transform into vertically vectored kinetic energy when the blasting agent hits mineralized and/or organic deposits. In a physical sense, the kinetic energy of the powder grain (E_k) is directly proportional to the mass (m) of the grain (kg) and the square of the speed (v^2; $m^2 \div s^2$).[43] The released energy creates microcracks in the structure of any substrate (including tooth deposits), leading to their subsequent spalling.[44,45] The energy transformation is expected to be associated with a significant heat development, which in case of dental air polishing is effectively combated by simultaneous water-cooling.

When reflecting on rubber cup polishing, the abrasive particles (perlite grains) generate angular kinetic (rotational) energy (E_r), which is directly proportional to the moment of inertia around the axis of rotation (I; $kg \times m^2$), and to the angular velocity (ω; $rad \times s^{-1}$).[43] While vertically vectored powder grains can reach the linear speed of approximately 400 km/h (≈ 111.1 m/s),[46] and a somewhat lower energy when striking the tooth surface from a slanted position (usually ranging from 30 to 60 degrees), the linear speed of the rubber cup (diameter 8 mm) only amounts to some 10 km/h (≈ 2.8 m/s) after conversion of the given 3,000 rpm applied during the conventional polishing procedure. Although this velocity is applied with the average pressure of 1 bar (≈ 14 psi),[47] further calculation would reveal a significantly lower kinetic energy, compared to the energy of the powder grains.

The question concerning the needs of further polishing of airborne-particle-abraded surfaces (which might be necessary, due to the previously described "corrasion" phenomenon) with a low-abrasive paste cannot be answered unambiguously, given the lack of sufficient evidence from the scientific literature. To the present authors' best knowledge, these thoughts were raised only in a few in vitro studies[23,26] conducted previously, leading to the assumption of potentially required finishing of the air-polished surfaces with conventional rubber cup and prophylaxis paste, despite the fact that the air-polished enamel seems to show similar surface roughness in comparison with surfaces treated conventionally,[23] and does not result in considerably increased surface loss or roughness.[26] Although the QHI sum scores collected for the test sites revealed a significantly better clinical performance of the air-polishing approach in the present study, even after the further cessation of personal oral hygiene measures, the explanation of the observed effects remains speculative in nature and requires further verification. It is most likely that the delayed repopulation of the enamel surface with microorganisms is not implicit due to enhanced surface smoothness, but rather to the already mentioned ability of air polishing to more deeply clean the surface without creating any (coarse) damage to the enamel; with an undisturbed biofilm regrowth, these differences should blur after a couple of days. The analysis of the positive slope lines (see Fig 3) connecting QHI sum score medians achieved immediately after the polishing and 24 hours later indeed seem to provide an indirect proof for a similar speed of microbial repopulation, regardless of the implemented polishing method. Nevertheless, in case a subsequent rubber cup polishing should be necessary, the desired gain of time (the application of air polishing is frequently associated with) should clearly be scrutinized.[22]

It is interesting to note that corresponding time recordings (results not shown), which were conducted along with the differing treatments in the course of the present study (thus serving for the planning of a further investigation), did not reveal any considerable advantages concerning the working time spent for air polishing in comparison with traditional rubber cup polishing. These preliminary findings clearly contradict the observations of a recently published, similarly designed RCT,[22] and might be astonishing at a first glance, but could, however, be easily explained. In the present investigation the study settings were thoroughly standardized to ensure a maximum control of the implemented methodologies by means of strictly heeding the manufacturer specifications (primary endpoint), including the order to clean three adjacent teeth for 10 seconds per tooth surface (in case of rubber cup method), followed by subsequent polishing of these surfaces for 5 seconds with the same portion of prophylaxis paste.[35] To investigate possible variances concerning the working time spent for the two polishing methods, air polishing and conventional rubber cup polishing, the primary endpoint should be defined as achieving a (more or less) plaque-free enamel surface. It may be speculated whether differences concerning the working time spent for these polishing methods would turn out in favor of air-polishing. However, these thoughts require further investigations.

The sensitivity of the semi-quantitative measurement techniques applied in the present investigation (modified QHI) should be considered with some caution, since the assessment procedure was based on a subjective evaluation of the uncovered biofilm, and this possible operator bias would constitute a clear limitation of the current study (even with the implemented blinded approach in mind). Though considered less costly or burdensome, recording of subjectively assessed indexes remains less accurate (if compared to objectively evaluated findings). At the same time, further disadvantages including the restricted representativeness of samples due to small temporal range and limited number (and age) of participants should be mentioned. With the comprehensive randomization, it was, however, possible to mitigate (at least to some degree) the influence of several confounders such as formation of certain tooth brushing patterns, possibly affecting the reliable detection of dental plaque. The involvement of blinded and objective evaluators can clearly be designated as an advantage of the present study. No doubt, it should be stressed that the utilization of different indexes and clinical parameters such as assessing bleeding, probing pocket depths, or measuring attachment loss remain the most common methods to evaluate the clinical performance of sub- and supragingival surface instrumentation.

However, the described methods do not provide any reliable information on abrasion wear and surface roughness. The latter has occasionally been investigated by some ex vivo studies, supported by exact laboratory-based methods of measurement.[23,26] To assure reliable results concerning clinically achievable surface finish by means of air polishing, serious efforts have to be targeted on the utilization of methods (ideally accompanied with a high accuracy of laboratory-based research), thus allowing investigation of different surface conditions in vivo. Regarding the assessment of the postoperative surface roughness resulting in conjunction with air polishing, the previously proposed ex vivo principle[48] (originally designed to investigate periodontal tissue damage related to air polishing) using a porcine model could be adapted for the use in human subjects. For this purpose, the corresponding instrumentation (air polishing or conventional polishing) of permanent teeth intended for balancing and compensating extraction would seem conceivable. Additionally, to clinically evaluate the long-term abrasive wear caused by repeated use of different polishing methods, the utilization of fluorescence-aided identification techniques (FIT) might be conceivable.[49] This method has recently been applied in clinical research concerning the investigation of abrasion resistance of restorative materials,[50] and could potentially be transferred into the field of digitally based investigations of surface alterations.

Conclusions

With the aims of the current RCT in mind, the supragingival professional biofilm management by means of air polishing with low-abrasive erythritol powder represents an efficacious alternative to conventional rubber cup polishing and should improve oral health care. The advantages of air polishing are based on its ability to reach hardly accessible dental structures, thus resulting in an enhanced clinical efficacy of supragingival debridement. As expected, significant new formation of supragingival biofilm was noticeable with both polishing methods; however, biofilm regrowth seemed to be deferred with the air-polishing approach. Despite some obvious advantages of the air-polishing system investigated in the current study, further (longitudinal) investigations seem mandatory, in particular with regard to possible abrasive damages to dental enamel as a consequence of frequent use of such devices under clinical circumstances.

Acknowledgments

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