

Episode #35 – Air Polishing

April 30, 2021

Air polishing was originally considered a cosmetic procedure. However, research has demonstrated that air polishing can have both an esthetic and therapeutic value when the appropriate air polishing powders and equipment are utilized.

Overview of air polishing

The concept of air polishing was based on technology developed by Dr. Robert Black in 1945. Dr. Black invented a device called the Air Dent that used compressed air, water, and a highly abrasive powder as a non-rotary method for cavity preparation. His technology became the basis for air polishing. By the late 1970s, air polishing was introduced to the oral health profession. The first air polishing device, the Prophy Jet Marck IV™, was marketed by Dentron, Incorporated (Corpus Christi, Texas).

Air polishing was initially developed to provide efficient and effective extrinsic stain and biofilm removal from supragingival enamel surfaces with less clinician fatigue and with the advantage of reaching difficult to access areas. In addition, air polishing does not generate heat. It is also useful for removing biofilm and stain from orthodontically bracketed and banded teeth and can be used to clean pits and fissures prior to sealant placement. However, supra- and subgingival air polishing does not remove calculus, as a result, it is not a replacement for ultrasonic or hand instrumentation.

Air polishing is achieved by the propulsion of abrasive particles in a mixture of compressed air and water through a handpiece nozzle. By activating the foot control, the handpiece nozzle propels the slurry onto the tooth surface. Air pressure settings and water/powder ratios vary between models. These settings determine the kinetic energy of the abrasive particles. The more kinetic energy, the more effect the particles will exert on the surface they contact. Air polishers are manufactured to attach directly to the air/water connector on the dental unit, as separate units, or in combination with an ultrasonic scaler.

The abrasive property of the air polishing powders delivered from the air polishing device is determined by the particle's velocity, hardness, mass, shape, and fragmentation ability; slurry contact time; concentration and quantity; and design principles of the air polishing device (e.g., amount of applied pressure)[1]. The particle's mass, determined by its density and size, significantly affects the particle's kinetic energy. When speeds are the same, a particle with more mass will have more energy

[1] Applied pressure is the force and load measured in pounds per square inch (psi).

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than a particle with less mass. The smaller the particle size, the finer the grit, the smaller the scratches, which means the shinier the tooth or restoration surface will be after air polishing. Increased hardness and angularity also increase abrasiveness, while the tendency toward fragmentation decreases abrasiveness. Comparing abrasiveness of air polishing powders can be difficult due to these variables. [1] [2] [3] [4] [5] [6]

Types of air polishing powders

Sodium bicarbonate ($NaHCO_3$) was the first powder used in air polishing and is still a very common powder on the market today. Sodium bicarbonate powders are processed with small amounts of calcium phosphate and silica to form a free-flowing powder. Only sodium bicarbonate powders specifically designed for air polishing are safe to use in air polishing devices. Utilizing over-the-counter sodium bicarbonate can clog and compromise the air polishing equipment.

Sodium bicarbonate particles are angular in shape with a size of up to 250 µm and an average size of 74 µm. The Mohs hardness[2] value for sodium bicarbonate is 2.5. Comparatively, pumice, the standard abrasive used in prophylaxis paste, has a Mohs hardness number of 6. Sodium bicarbonate is effective in removing most stains and is safe for intact enamel and amalgam restorations when proper technique is used.

Research also shows that sodium bicarbonate air polishing is approximately one-third less time consuming when compared with hand instrumentation and rubber cup polishing for stain and biofilm removal. However, it can significantly damage dentin and cementum, as well as composite and glass ionomer restorations. Additional disadvantages include its salty taste and potential for soft tissue trauma. Research has demonstrated that air polishing with sodium bicarbonate has been shown to result in substantial gingival erosions when directed toward the gingiva. [1] [3] [7] [8] [9]

Aluminum trihydroxide ($Al[OH]_3$) was the first air polishing agent developed as an alternative to sodium bicarbonate powders for clients who are sodium intolerant. Its particles range from 80 µm to 325 µm in size, comparable in size to sodium bicarbonate. However, it has a Mohs value of 4 making it more abrasive than sodium bicarbonate. Its hardness and large particle size make it an excellent stain remover, but its use is limited to enamel. Contraindications include use on dentin, cementum, amalgam, gold, all composite types, glass ionomers, and implants. Aluminum trihydroxide does not cause surface disruption to porcelain. However, the luting agents used for placement of porcelain restorations are removed by aluminum trihydroxide, causing a compromise in the margin integrity that could quickly lead to decay. [1] [5] [7]

Calcium carbonate ($CaCO_3$) powder has rounded shape particles and a Mohs value of 3. Its average particle size is 45 µm, which is less than sodium bicarbonate. It is a naturally occurring substance that can be found in rocks. It is used as pharmaceutical filler in pills and tablets and is a main ingredient in antacids. Studies indicate the

[2] Mohs hardness scale was devised by Friedrich Mohs, a German mineralogist in 1826, and was originally based on the susceptibility of a mineral to be scratched. It is a standard 10-point scale with talc, the softest, numbered 1 and diamond, the hardest, numbered 10.

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efficiency and effectiveness of calcium carbonate for stain removal; however, it can cause defects on root surfaces. [5] [10]

Calcium sodium phosphosilicate ($CaNaO_6PSi$) is a bioactive glass, which is a chemical compound of naturally occurring elements including calcium, phosphorus, silica, and sodium. It has a Mohs hardness value of 6, making it the hardest air polishing particle used. The particles vary from 25 to 120 µm in size. Calcium sodium phosphosilicate removes stain but is also marketed as a therapeutic air polishing powder for treatment of dentin hypersensitivity and repair of dental tissues. The powder has remineralization properties and may occlude dentinal tubules because it contains calcium and phosphorus. With its remineralizing capacity, it may have application in treatment of white spot lesions. [5] [7] [11]

Glycine is a naturally-occurring nonessential amino acid. It is water-soluble with a sweet, non-salty taste. Water solubility is important for ease of removal from the gingival sulcus after air polishing treatment. It has a mean particle size of less than 45 µm and a maximum particle size of 63 µm, close to 4 times smaller than sodium bicarbonate particles. It has a Mohs hardness value of 2. Glycine's low abrasiveness enables it to be used safely supragingivally around gingival tissue as well as subgingivally. It can also be safely used on restorative materials and dental implants, and for the debridement of periodontal pockets. Research has demonstrated that air polishing with glycine powder is safe for the removal of biofilms from the surface of gingiva and other oral mucosae. Glycine powder is not as effective at removing tenacious stain when compared with traditional sodium bicarbonate powder.

An overall beneficial change in the oral bacteria can occur as a result of air polishing subgingival sites and the oral mucosa (labial, palatal, buccal, and tongue) with glycine powder. For example, research found that after 90 days the amount of the periodontal pathogen *Porphyromonas gingivalis* was reduced in shallow pockets and throughout the oral cavity with full mouth glycine powder air polishing compared to traditional periodontal maintenance therapy. [3] [6] [9] [10] [12]

Erythritol ([2R,3S]-butane-1,2,3,4-tetraol) is a noncariogenic sugar alcohol and is used as a sweetener in a variety of products. It has a Mohs hardness value of 2 and a particle size of 14 µm. It is a low-abrasive powder that can be used for subgingival air polishing. Erythritol powder is water soluble and can also be safely used on restorative materials and dental implants, and for the debridement of periodontal pockets. In comparison to glycine powder, erythritol produces a smoother surface when used on dentin. Also, significant improvements in plaque index scores, bleeding on probing, and probing depths have been seen with subgingival air polishing with erythritol powder. [3] [12] [13]

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Comparison of air polishing powders [7] [12] [11]

Abrasive	Particle size (µm)	Mohs hardness scale	Use & benefits	Relative Contraindications	Disadvantages
Sodium bicarbonate ($NaHCO_3$)	≤250 74 average	2.5	• Effective supragingival stain and biofilm removal • Decreased time for biofilm and stain removal • Safe on enamel	• Blood pH conditions • Sodium-restricted diets • Composite and glass ionomer restorations • Root surfaces • Implants	• Contribute to root surface defects • Possible gingival erosion • Surface defects on restorative materials • Salty taste • Does not remove hard deposits
Aluminum trihydroxide ($Al[OH]_3$)	80 to 325	4	• Supragingival stain and biofilm removal on anatomic crown • Alternative to sodium bicarbonate • Heavy stain	• All restorations • Root surfaces • Implants	• Does not remove hard deposits
Calcium carbonate (CaCO3)	45	3	• Supragingival stain and biofilm removal on anatomic crown	• Blood pH conditions • Implants	• Does not remove hard deposits
Calcium sodium phosphosilicate ($CaNaO_6PSi$)	25 to 120	6	• Supragingival stain and biofilm removal on anatomic crown • Remineralization • Desensitization	• Possible abrasive effects to composite and glass ionomer restorations • Implants • Silica allergies	• Does not remove hard deposits
Glycine (amino acid)	≤63 45 average	2	• Supra- and subgingival biofilm removal • Implants		• Does not remove hard deposits • Cost
Erythritol ([2R,3S]-butane-1,2,3,4- tetraol)	14	2	• Supra- and subgingival biofilm removal • Implants		• Does not remove hard deposits • Cost

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Mohs hardness values [14] [15] [16]

Material	Mohs hardness
Cementum	2 – 3
Dentin	3 – 4
Enamel	5 – 6
Denture acrylic	2 – 3
Gold	2.5 – 3
Dental amalgam	4 – 5
Titanium	4 – 5
Glass ionomer	5 – 7
Composite	5 – 7
Dental porcelain	6 – 7
Zirconia	8

Health and safety concerns with air polishing

Contraindications may include a sodium-restricted diet, hypertension, history of allergic reaction to the powder, respiratory diseases, infectious disease, renal insufficiency, Addison's disease, Cushing's disease, metabolic alkalosis or medications, such as mineral corticoid steroids, antidiuretics, or potassium supplements. Products that do not contain sodium (e.g., glycine, erythritol, calcium carbonate, aluminum trihydroxide) are not contraindicated for conditions, such as sodium-restricted diet, hypertension, or renal insufficiency. Calcium sodium phosphosilicate powder has a very small amount of sodium mixed with the particles and no salty aftertaste. There have been no medical contraindications associated with calcium sodium phosphosilicate powder; however, it is not recommended for clients with silica allergies.

Sodium bicarbonate and calcium carbonate should not be used on clients who have limited buffering capacity against pH changes in the blood because carbonates can affect blood pH. This includes clients with kidney disease or adrenal dysfunction, as well as those taking mineral corticosteroids.

Though incidences are rare, use of pressurized air can result in facial subcutaneous emphysema if air penetrates into a connective tissue space. Symptoms of facial emphysema include facial swelling, tenderness, and pain. Clients exhibiting these symptoms must receive immediate medical care to prevent serious health problems. This highlights the iatrogenic potential and reinforces the importance of following manufacturer's instructions.

Air polishing is an aerosol generating procedure so precautions such as high-volume evacuation should be utilized along with other infection, prevention, and control measures. [6] [7] [17]

Recent research

Janiszewska-Olszowska et al. (2020) conducted an *in vitro* study to compare the effects of sodium bicarbonate, glycine, and erythritol air polishing powders on the surface roughness of microhybrid restorative composite material. The research found that

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sodium bicarbonate had a greater detrimental effect on the composite surfaces than glycine or erythritol. Further, there were no differences when comparing erythritol to glycine. [18]

Tuchscheerer et al. (2020) compared the efficacy of three different combinations of glycine powders, air polisher handpieces, and nozzle tips for implant surface decontamination in surgical and non-surgical *in vitro* simulations. The results indicated that the use of glycine-based air polishing devices achieved high cleaning efficacy in non-surgical and surgical simulations, regardless of the device manufacturer and the type of intraosseous defect. There was also no damage to implant surfaces after glycine air polishing. Nevertheless, complete surface decontamination of the implants was not achieved with any of the devices. The authors concluded that air polishing was an efficient, surface protective method for surgical and non-surgical implant surface decontamination in their *in vitro* model. [19]

Kröger et al. (2020) conducted an *in vitro* study to evaluate the amount of dentin lost by air polishing with erythritol at different pressure settings, distances, and angulations of the jet spray to the root surface. The researchers found that air polishing with erythritol caused a small but measurable amount of dentin loss but was very low compared to hand and ultrasonic scaling. The amount of loss varied depending on the combination of the tested parameters. For example, the depth of the defect caused by air polishing was directly related to the working distance of the nozzle from the tooth and the angulation of the nozzle. This stressed the importance of following the manufacturer's instructions when air polishing to prevent any unintended side effects. This would include maintaining the proper working distance and nozzle angulation while also utilizing a sweeping motion to prevent damage to tooth structures and restorative materials. [20]

Cosgarea et al. (2021) conducted a randomized, controlled, clinical pilot study of 30 systemically healthy participants with stage III-IV periodontitis. Each participant underwent a single-rooted periodontal flap surgery and were randomized to either a test group (i.e., calculus removal with a blade and erythritol air polishing) or control group (i.e., calculus remove by hand and ultrasonic scaling). Probing depths, clinical attachment, bone sounding, and radiographic bone levels were evaluated at baseline and 12 months post-surgically.

In both groups, statistically significant improvements were obtained in mean clinical attachment measures and probing depths, with no statistically significant differences between the groups for any of the investigated parameters. The authors concluded that the results indicated that the use of air polishing with an erythritol powder during periodontal surgery may represent a valuable minimally invasive adjunct following calculus removal by hand and ultrasonic instruments, or a valuable method for biofilm removal from calculus-free root surfaces. Also, the study's results together with available data from other preclinical and clinical studies suggested that air polishing with erythritol is efficient for biofilm removal with less root substance loss compared with hand and ultrasonic debridement. [21]

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Janaphan et al. (2020) conducted a review of the literature to provide an overview of air polishing powders and the effectiveness of air polishing procedures in subgingival debridement of periodontal pockets during supportive periodontal care. Note that their review did not include studies that used air polishing procedures for dental implants. The main findings of the review included:

- Air polishing is capable of effectively removing subgingival biofilm, offering similar treatment outcomes in probing pocket depths, bleeding on probing, and clinical attachment measurements when compared to conventional therapy (e.g., utilization of hand curettes and/or ultrasonic scalers).
- A systematic review comparing ultrasonic debridement with subgingival air polishing in supportive periodontal therapy showed that neither ultrasonic debridement nor air polishing demonstrated superior clinical effects and both showed similar clinical efficacy in single- and multi-rooted teeth without furcation involvement.
- Air polishing resulted in less client discomfort and a higher level of client acceptance.
- A nozzle designed for subgingival debridement reduced the pressure of the jet spray and allowed both the air and powders to exit horizontally, thus minimizing the risk of subcutaneous emphysema. The nozzle was tested on periodontal pockets up to 9 mm with no adverse events detected.
- Trehalose[3], which is a nonreducing and noncariogenic disaccharide, has recently been introduced for air polishing. The powder size of 25-35 µm is similar to the size of glycine powder and has been used subgingivally in residual periodontal pockets of clients in maintenance therapy. The results showed that the clinical outcomes were comparable to ultrasonic debridement with less client discomfort.
- Calcium sodium phosphosilicate powders (i.e., bioactive glass) chemically react with tooth surfaces once exposed to the aqueous environment of the oral cavity resulting in dentinal tubule occlusion and alleviation of dentinal hypersensitivity.
- Repeated subgingival air-polishing with erythritol powders in non-resolving sites during periodontal maintenance resulted in the reduction of the number of deep pockets similar to ultrasonic debridement procedures leading to a lower detection of *Aggregatibacter actinomycetemcomitans*.
- Full-mouth application of glycine air polishing (i.e., including all teeth supra- and subgingival and the oral mucous membranes), resulted in a beneficial shift of the oral microbiota compared to conventional debridement. In contrast, it was reported that air polishing did not demonstrate any superior outcomes in the reduction of periodontal pathogens when compared to hand or ultrasonic instrumentation.
- It was also demonstrated that air-polishing could promote a stable periodontal condition during three-month maintenance intervals by reducing the pathogenicity of the subgingival microbiome and counteracting the rebound of periodontal pathogens due to the recolonization of the microflora.

[3] Trehalose is a sweet-tasting, highly water-soluble disaccharide. It is found naturally in plants, invertebrates, fungi, and microorganism and is therefore present at low levels in a variety of foods (e.g., bread, beer, wine, honey, mushrooms, etc.). It is used as a food additive.

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- Subgingival air polishing with glycine or erythritol powders was deemed more acceptable by clients since it caused less gingival irritation and a lower perception of pain during treatment and required less chair-time compared to conventional methods. [22]

Ulvik et al. (2021) conducted a randomized clinical trial that included 20 individuals with grade II mandibular molar furcation defects were either treated with debridement using the erythritol air polishing system (test) or conventional ultrasonic and curette instrumentation (control) at baseline, and at 3, 6, 9, and 12 months. Probing depths, clinical attachment measurements, and bleeding on probing were recorded at 3-month intervals. Subgingival microbiological samples were analyzed at baseline, 6, and 12 months. Discomfort from treatment was assessed at 12 months.

The authors concluded that the 12-month observations indicated that erythritol air-polishing and conventional mechanical debridement both support clinical improvements. A significant between-treatment difference in clinical attachment measurement was, however, detected in favour of the control debridement at 6 months. Treatments displayed similar effects on the subgingival microflora. In terms of client comfort, erythritol air-polishing was superior. [23]

Mensi et al. (2021) evaluated the benefits of subgingival air polishing during non-surgical treatment of deep bleeding pockets. Forty participants with stages III–IV periodontitis were selected, and periodontal pockets with probing depths of 5-9 mm and bleeding on probing were selected as test sites. All participants underwent a full-mouth session of erythritol powder supragingival air polishing and ultrasonic instrumentation. The test group received an additional subgingival air polishing at test sites.

The researchers found that the additional application of subgingival air polishing did not seem to provide any significant clinical advantage in achieving closure of moderate to deep bleeding periodontal pockets. They determined that air polishing could play a role in biofilm removal at supragingival and shallow sites; however, ultrasonic root surface debridement alone was still the choice for initial treatment of deep bleeding periodontal pockets. [24]

Take home messages

Air polishing is a safe and effective adjunctive method of biofilm management when proper technique and powders are used. The use of glycine and erythritol powders have demonstrated less potential damage to the gingiva, oral mucosa, cementum, and dentin, as well as to various restorative materials and implants. Compared to conventional biofilm removal methods, air polishing can be a more efficient and comfortable treatment option for clients undergoing periodontal maintenance therapy. Additional research with varying device nozzles and powders is required to provide additional evidence on safety, efficacy, and treatment outcomes and recommendations.

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Additional Resources

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