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Air-Powder Polishing: An Update

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Bacterial plaque is the principle cause of initiation of gingivitis and periodontitis. Removal of this bacterial plaque is essential for maintainence of healthy periodontium. Conventional methods employed for removal of plaque had certain drawbacks like loss of healthy tooth structure causing increased dentinal hypersensitivity, time-consuming procedure, could cause gingival lacerations and gingival bleeding, need to sharpen the instruments, operator fatigue. The air-powder abrasive system produces desired removal of plaque and other debris, surface smoothness with less operator fatigue and prevent loss of tooth structure thereby decreasing incidence of hypersensitivity and gingival tissue lacerations. Nowadays, powders with different compositions, particle sizes and applications are available. The choice of the abrasive powder depends on the device used, the operator's choice, the type of deposit to be removed and the medical contraindications. Hence, the newer minimally abrasive air powder polishing system is an effective alternative to conventional oral prophylaxis.

Keywords: Air-powder polishing; tooth polishing; plaque; stains; non-surgical periodontal therapy; biofilm; plaque control; abrasives; occupational hazard; aerosols.

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ABBREVIATIONS

SA APD	*: Stand-Alone type of Air Polishing Device*
$NaHCO_3$	*: Sodium Bicarbonate*
$CaCo_3$	*: Calcium Carbonate*
$CaNaO_6PSi$	*: Calcium sodium phosphosilicate*
$Al(OH)_3$	*: Aluminum trihydroxide*
PPE	*: Personal Protective Equipment*
GPAP	*: Glycine powder air polishing*
SPT	*: Supportive periodontal therapy*
CFU	*: Colony forming units*
VAS	*: Visual Analogue scale*
GAPA	*: Glycine air powder abrasion*
SEM	*: Scanning electron microscope*
SRP	*: Scaling and root planing*
IL-6	*: Interleukin-6*
TNF-α	*: Tumor necrosis factor- alpha*
PD	*: Probing Depth*
BOP	*: Bleeding on Probing*
PI	*: Plaque Index*
GI	*: Gingival Index*
CRP	*: C-reactive Protein*
GCF	*: Gingival crevicular fluid*

1. INTRODUCTION

In the year 1945, Dr Robert Black introduced the concept of Air Polishing. He invented a device named Air-Dent which utilized abrasive powder, water along with compressed air and used it to eliminate pain during cavity preparation, overcoming the need for anaesthesia.[1]

Bacterial plaque accumulation is the root cause for initiation of gingivitis as well as periodontitis. Oral prophylaxis at regular intervals is the key to prevent progression from gingivitis to periodontitis. Earlier, mechanical plaque removal with help of periodontal instruments was the only method available for plaque control. But the irreversible damage like loss of tooth structure [2-5], gingival recession [6] and increase in dentinal hypersensitivity [7-14] was found associated with mechanical plaque control. It was noted that increased dentinal hypersensitivity to tactile, thermal, osmotic and evaporative stimuli was found in treated teeth. [15-19].

The main goal of periodontal therapy is to achieve a tooth surface which is conducive for maintenance of dento-gingival health. [20] It also requires the removal of external deposits along with plaque from the surface of the tooth for complete elimination of bacteria and the bacterial by-products from the periodontium. [21].

The amount of plaque accumulation is dependent upon the degree of roughness of the tooth structure. As a result, rougher the tooth surface, the more will be the plaque accumulation and smoother the tooth surface lesser will be the plaque accumulation. [22-25]

Newer air-powder polishing technology, which is non-invasive, painless and utilizes an abrasive powder through a stream of compressed air to clean as well as polish tooth surface, does not alter the dentin or enamel surfaces. As a result, Air-powder polishing is a game-changer in the field of Periodontology. The main aim of the review is to remind clinicians about this older technology, using newer non-abrasive powders, and its advantages in periodontal therapy.

2. DEFINITIONS

- **Tooth Polishing** : The American Academy of Periodontology defines tooth polishing as [in relation to oral prophylaxis] “the removal of plaque, calculus and stains from the exposed and unexposed surfaces of the teeth by scaling and polishing as a preventive measure for the control of local irritational factors.” [26]

- **Selective polishing**: The process of cleansing and polishing tooth surfaces to remove extrinsic stains that may remain after scaling using a latex-free cup and or bristle brush on a prophylaxis angle attached to a low- speed handpiece or with an air-powder polishing device, and an appropriately selected abrasive agent; however, cleansing and polishing are omitted on surfaces already stain free.[27]

- **Air polishing** : The process of cleansing and polishing the dentition and dental restorations using a device that mixes air and water pressure with an abrasive agent such as sodium bicarbonate powder, aluminum trihydroxide, calcium sodium phosphosilicate powder, or calcium carbonate powder to remove extrinsic stain remaining after scaling. [27]

- **Therapeutic polishing** ⍰ Refers to “the polishing of the root surfaces that are exposed during surgery to reduce endotoxin and microflora on the cementum.”

- **Coronal or cosmetic polishing** It is defined as “a procedure designed to make the tooth free of plaque and extrinsic stains.” The process of achieving a smooth, mirrorlike enamel or material surface that reflects light and is characterized as having a high luster; accomplished with a fine to extra fine grit abrasive agent so that the surface scratches are smaller than the wavelength of visible light (<0.05m).

- **Superficial polishing** It is a term often related to the polishing of the crown of the tooth and now considered as a cosmetic procedure with minimal therapeutic benefit.

- **Selective polishing** Is another word often used by hygienists. It is used to indicate that cleansing and polishing procedures are only provided when justified by the tooth surfaces that have visible stains after scaling, and oral debridement is complete. Selective polishing is also known as extrinsic stain removal or selective stain removal. The most accurate term for all of these procedures is selective stain removal, which indicates the removal of extrinsic stains after professional scaling, using a rubber cup or bristle brush, and polishing paste, and/or air powder polishing system; though everything depends on the assessed needs of the patient. It means cleansing and polishing are omitted on surfaces already stain free. [27]

3. AIR-POWDER POLISHERS

Originally, air polishers were intended for use only on supragingival tooth surfaces owing to their abrasive nature which could cause harm to surrounding periodontal tissues. However, now due to advancements in powder abrasivity, these newer powders may be safely and effectively employed subgingivally as well.

The mechanism of action varies upon the type of air polisher. The stand-alone type of air polishing device (SA APD) works on the swirling action of air and powder. The hand-piece type of air polishing device works on the carburetor and swirling created by mixture of air and powder. High variability in powder emission rates at different powder settings is observed between the air polishing devices, this affirms that the amount of powder released depends on the way the pressurized air is led through the powder chamber Petersilka et al.

The procedure of polishing always proceeds from coarse abrasion for cleaning and to fine abrasion for polishing, with the use of finer grades of abrasives. [28,29]

While heavy extrinsic stains may require medium or coarse abrasive pastes, the most commonly used abrasive is the fine grit. The polishing process proceeds by producing smooth, shiny scratches <0.5 mcm on the tooth surface which are smaller than the wavelength of visible light. The degree of abrasion caused on the tooth surface is dependent on the tooth surface integrity and the clinician’s efficiency. [30-31] In vitro studies have shown that an average of 636.µm of root structure may be removed within 30 seconds of time. [32] Factors contributing to the efficiency of plaque removal from the tooth surfaces are : rotations per min of the rubber cup polisher, abrasive paste/slurry coarseness, rubber cup-to-tooth load or pressure and lastly, the total time required to polish each tooth. [33]

4. TECHNIQUE

Air powder polishing should be carried out under the following considerations : [30]

i. Usage of proper technique to avoid unnecessary abrasion of exposed enamel and dentinal surfaces
ii. Selection of the least abrasive polishing powder will help eliminate extrinsic stains and bacterial plaque
iii. Cognisance of the total time, and surface movement required for the entire procedure
iv. Cognisance of which powder may be too abrasive for each type of restoration material.

Newer technologies in air polishing devices utilize compressed air with water along with a variety of powders available in varying particle sizes, that are indicated for specific treatments. The handpieces for applying these powders are either directly attached to the water/air connector on the dental unit or available in combination with ultrasonic scaler device. These devices emit a well-controlled jet, and sprays the selected powder particles on the surface of the tooth when activated by foot control Barnes et al. [34]

5. MECHANISM OF ACTION

The device generates kinetic energy, and thus propels the powder slurry through the nozzle of the handpiece against the surface of the tooth. The nozzle is ideally angled away from the gingiva when used supragingivally at a distance of 3-4mm from the tooth. This helps to minimize the abrasive action but this is known to increase the aerosols. Once the tip is angled diagonally, the slurry is directed in a constant circular motion towards the middle one third of the surface of the tooth, also with interproximal sweeping or paint brush motion. The tip should be directed at a 60°angle for anterior teeth, 80° for posterior teeth, 90° for occlusal surfaces.[30] During the procedure, inlet air pressure of 40 and 100 psi along with inlet water pressure between 20 to 60 psi is preferred.

However, according to Francis and Barnes, the psi produced varies upon the type of abrasive powder and air polisher being used [30]

Treatment effectiveness is dependent upon : The abrasive powder to water setting, the distance of the jet from the treated tooth surface, and the shape and size of the abrasive particles used[35]

6. INDICATIONS

Removal of plaque biofilm (especially in patients on supportive periodontal therapy), removal of extrinsic stains, cleaning around orthodontic braces and appliances, removal of plaque prior to topical fluoride application, cleaning occlusal grooves prior to pit and fissure sealant application, can be used for plaque control in patients on supportive periodontal therapy, polishing removable prosthesis, plaque control around implants and in treating peri-implantitis.[36]

7. CONTRAINDICATIONS

Patients having any communicable diseases, respiratory diseases such as emphysema, [37-42] sodium restricted diets, allergy to any ingredient in air polishing powders. Contact lenses are not ideal candidates for air polishing, however all patients should be outfitted with protective eyewear during treatment. Further, due to advancements in air polishing, sodium restriction is less of an issue now. To date, not a single case of emphysema has been reported after subgingival air polishing in shallow pockets using glycine containing air polishing powder.[43-45]

8. AIR-POWDER POLISHING POWDERS

The Air polishing particles available in commercially available powders are Glycine, Clinpro™ glycine powder (3M™ ESPE™, Seefeld, Germany), Calcium sodium phosphosilicate (Sylc™; OSspray, London, UK), Calcium carbonate (Prophypearls™; KaVo, Charlotte, NC) and Aluminum trihydroxide (Jet–Fresh™; DENTSPLY, York, Penn), $NaHCO_3$ powders (Acclean Air Preventive Powder™; Henry Schein, Lange, Germany, and Air–Flow Prophylaxis Powder™; EMS, Nylon, Switzerland). Manufacturers of glycine, calcium sodium phosphosilicate and calcium carbonate claim that these powders are less abrasive compared to traditional sodium bicarbonate–based powders. Other powders available are that containing silicondioxide, carbide compounds, garnet, feldspar, zirconium silicate, zirconium oxide, boron, emery, silica, perlite, erythritol, aluminium silicate, silicon carbide, etc. [46]

One of the first powders developed was a Sodium bicarbonate based abrasive powder ($NaHCO_3$). They are still available with a powder particle size of 250μm. This powder is considered ideal for effective decontamination of pits and fissures on the occlusal surfaces of molars and premolars. Literature published to date, confirms the safety and efficacy of the supragingival use of $NaHCO_3$ when compared with manual scaling and rubber-cup polishing[47]

- **Glycine** is a naturally occurring amino acid that is finer, less abrasive, and water-soluble. It can be used subgingivally and is tasteless. It was first isolated from sugarcane in 1820 by Braconnot (La Rousse Enciclopedia Rizzoli, 1964). It has particle size of 63 μm or less, 4 times smaller than the particle size of $NaHCO_3$. Glycine has shown to remove bacterial plaque more efficiently than hand instruments. Polishing done with powders containing glycine is known to cause less discomfort during non-surgical periodontal therapy, that is to say supra- and subgingival air polishing. Polishing with glycine causes less gingival erosion as well as an 80% reduction in abrasiveness on root surfaces than found after use of hand instrumentation or sodium bicarbonate air�polishing. In pockets greater than 5mm with inflammation, a periodontal subgingival tip and the use of glycine powder is recommended. [47-49]

- **Calcium carbonate (CaCO3)** (Prophypearls™; KaVo, Charlotte, NC) contains uniformly shaped spherically agglomerated crystals with 45 μm will minimize surface abrasion when compared to the irregularly shaped particles found in other powders and thus results in better polished surface. Results of a few studies proved the effectiveness and efficiency of CaCO3 in air polishing powders for extrinsic stain removal. However, it also produced defects on root dentin that were greater than those caused by $NaHCO_3$. [50-51]
- **Calcium sodium phosphosilicate powder, (CaNaO6PSi)** (Sylc™; OSspray, London, UK) is a bioactive glass containing chemical compounds of calcium, phosphorus, silica and sodium. Bioactive glass aids in promoting the regeneration of affected tooth surfaces creating an enamel–like preventive layer and in profound whitening compared to $NaHCO_3$ [52]

  Powders containing (CaNaO6PSi) are known to reduce dentinal hypersensitivity as well as removal of plaque biofilm and extrinsic stains. Sauro et al confirmed CaNaO6PSi's aids in reducing dentinal permeability by occluding the dentinal tubules when used during air polishing and conventional rubber–cup polishing procedures. Its mechanism of action is similar to that of $NaHCO_3$. Banerjee et al, in studies comparing dentinal hypersensitivity, concluded that (CaNaO6Psi) resulted in a statistically significant reduction in dentinal hypersensitivity 10 days following the treatment whereas sensitivity increased for those subjects treated with $NaHCO_3$ [53,54]
- **Erythritol** is a sugar alcohol, when mixed with 0.3% chlorhexidine can help reduce periodontal pockets greater than 4mm. A recent study conducted to evaluate repeated subgingival air-polishing in residual pockets with an erythritol powder containing 0.3% chlorhexidine, concluded reduction in probing depths >4 mm acheived similar results to ultrasonic debridement. Erythritol polishing causes less pain than ultrasonic debridement and is safe to use subgingivally. [55]
- **Aluminum trihydroxide (Al(OH)3)** (JET–Fresh™; DENTSPLY, York, Penn) gained importance in air polishing powders due to their suitability for patients on sodium restricted diets. However, it is rather hard particle, and comparable to that of sodium bicarbonate. Johnson et al 2004 evaluated the effects of aluminum trihydroxide on restorative materials including amalgam, gold, hybrid and microfilled composites, glass ionomer cements and ceramic and concluded that this powder should be avoided completely on cast restorations, luting cements, glass ionomers and resin composites. [56]
- **Powder flowmeter**- This commercially available device helps to detect the amount of abrasive powder emitted in the hollow cylinder through the use of an optical fibre fixed perpendicular to the laser beam. First the powder passes through the laser beam followed by subsequent detection of emitted light with a help of spectrometer. The total quantity of powder passing through the system can be recorded by weighing the powder chamber of the device before and after the test using a precision scale (Mettler Toledo XP100012S, Greifensee, Switzerland). [57]

9. CHARACTERISTICS OF ABRASIVE POWDERS

The abrasiveness of the air-polishing powders differ based on their physical characteristics and the polishing device used. These physical characteristics are as follows: [58]

a. **Hardness:** The hardness of abrasives is ranked using Mohs Hardness Scale, a standard 10-point scale of mineral hardness with talc 1 the softest and diamond the hardest.

b. **Particle size [grit]:** The smaller [finer] the grit, the smaller the scratches, which means the shinier the tooth or restoration surface will be after polishing.

c. **Particle shape:** Small, spherical-shaped particles abrade slower than large, angular, irregular shaped particles.

d. **Agent contact time :** A single tooth surface is polished for 5 seconds to 10 seconds, for a total of 20 seconds to 40 seconds per tooth.

e. **Applied pressure** [force, load, measured in pounds per square inch [psi].

f. **Concentration and quantity**

g. **Abrasiveness:** Manufacturers of Glycine, Calcium sodium phosphosilicate and Calcium carbonate claim these powders are less abrasive than traditional Sodium bicarbonate–based powders.

10. EQUIPMENTS REQUIRED FOR AIR-POWDER POLISHING

- Air polishing powder and low-abrasive toothpaste.
- Air-polishing device and toothbrush.
- Dental floss or tape.
- Mouth mirror, air-water syringe.
- Disclosing solution.
- Lubricant
- Saliva ejector and high-volume evacuation [HVE] tip.
- Safety glasses.
- Personal protective equipment [PPE].
- Pre-procedural antimicrobial mouth rinse.

11. SAFETY PROTOCOL TO BE FOLLOWED FOR PREVENTION OF COVID-19 DURING AIR POWDER POLISHING FOR THE PATIENT AND THE OPERATOR

11.1 For the Operator as well as for Assistant

Wear appropriate PPE Kit before entering the dental operatory and initiating the procedure.

11.2 For the Patient

i. Proper Travel history, systemic history and pharmacologic history should be noted. The patient is instructed to wear protective eyewear, headcap and gloves before entering the dental operatory.

ii. Explain the procedure to the patient and have him/her remove contact lenses, if wearing. Gutmann suggested following universal precautions, using high–volume evacuation instead of a saliva ejector and rinsing with an antimicrobial mouthwash before treatment to prevent any potential health risks. [59] Preoperative rinse with an antibacterial mouthwash for about 30 seconds if it is a mouthwash with essential oils, or 2 rinses with 0.2% chlorhexidine for 60 seconds, to lower the bacterial load and reduce the risk of transport of bacteria in the aerosol. [60-62]

iii. Take care to preserve the lingual mucosa and the ducts of the parotid salivary gland.

iv. Apply lubricant to the lips to prevent the sodium bicarbonate from causing dehydration and abrasion during the procedure.

v. Use Modified pen grasp and external soft tissue fulcrum.

vi. Use moistened 2×2cm swabs or gauze to protect the soft tissues of the cheeks.

vii. A mouth mirror and proper suction system should be used to prevent the powder jet from passing through the spaces between the teeth and reaching the mucosa of the cheeks, tongue, palate or floor of the mouth.

viii. Activate foot pedal by pushing halfway down for water and all the way down for combined air-water-powder spray.

ix. Pivot nozzle to surface being polished with the tip directed at a 60 [degrees] angle to the tooth for anterior teeth, 80 [degrees] for posterior teeth, and a 90 [degrees] for occlusal surfaces of teeth. [63]

x. The nozzle should remain about 3 to 4 mm from the tooth surface and at correct angulation, with use of constant rapid circular sweeping motions, from proximal to proximal.

xi. Polish just two to three teeth at a time by fully depressing the foot pedal, then rinse the teeth and tongue by pressing the foot pedal half way, to increase efficiency and minimizes the saline taste.

xii. Polishing for 5 seconds or less per tooth is adequate to remove most stains. If stains are not removed completely, continue for up to another 20 seconds.

xiii. Particular attention should be paid to avoid irritating the floor of the mouth, the soft palate and the pharynx. [64]

xiv. The fine particles of powder may enter the eyes and beneath contact lenses, so the patient is advised to wear protective eyewear during the polishing treatment.

xv. A cheek retractor should be used to increase the operator's view. [65]

xvi. The supra- and subgingival air-polishing systems produce an abundant jet of water containing oral debris, abrasive powder, saliva. Thus, there is an increased risk of contamination in the dental operatory due to these aerosols.

xvii. Advise patient to avoid eating, drinking or rinsing for next 30 minutes. [66]

A study conducted at the Baylor College of Dentistry in 2004 by Harrel and Molinari advocated the importance of using a high-speed suction, along with a broad tipped aspirator positioned opposite to the jet, as close as possible to the nozzle. A saliva ejector does not provide sufficient suction to capture the aerosols related during treatment. (Harrel & Molinari, [61]

12. EVALUATION OF COMPLETION OF POLISHING PROCEDURE

At the end of polishing procedure, the teeth should be inspected thoroughly using a mouth mirror, intra‐oral light, compressed air and disclosing solution. Residual biofilm or stains, not reachable by air polishing, should be removed by either re‐instrumentation or re‐polishing the surface. Introducing some polishing paste interdentally on dental tape (or careful use of a finishing strip) before flossing may be needed for the removal of residual interproximal extrinsic stains.

13. AIR-POLISHING DEVICES

In early 1980s, air polishing devices were invented for efficient removal of extrinsic stains and bacterial plaque from the tooth surface with less operator fatigue and for plaque removal from inaccessible areas (Willman et al 1980, Atkinson et al 1984, Berkstein et al 1987, Kozlovsky et al 1989). The first device marketed by Dentron was Prophy Jet Marck IV™, then the Jet Shield™. Few other air polishing devices are Prophyflex 3 (Kavo), EMS Handy (EMS). 21

COMBI *touch* is a newly invented device combining a multifunctional piezoelectric scaler and a jet polisher, marketed for supra and sub-gingival oral prophylaxis. Its mechanism of action depends on a jet of crystals accelerated by a compressed airflow. The kinetic energy generated within the device strikes the abrasive particles against the surface of the tooth and produces a gentle cleaning action. This device has shown excellent hygiene and cosmetic results; removing stubborn extrinsic stains. Sodium bicarbonate based powder is preferred for supragingival prophylaxis whereas glycine-based powder is preferred for subgingival prophylaxis. [36]

14. EFFECTS ON RESTORATIVE MATERIALS, SEALANTS, ORTHODONTIC APPLIANCES AND IMPLANTS

14.1 Effect on Restorative Materials

According to Gutmann, clinicians are advised to follow instructions when the air polishing procedure is carried out.[59] Recent studies using new powders are limited but have indicated that during air polishing, restorative materials such as composites and ceramic veneers may experience a small but noticeable material loss. [67-68] Giacomelli et al 2001 found that the use of 20 psi during air polishing was more effective in reducing abrasion on restorative surfaces than 60 psi used in earlier studies. 69 The air polished amalgam surfaces lack any evidence of macro cracks, chips, on surface of composite restorations, and ceramic surfaces.

Air polishing on composite restorations with glycine powder, using 5, 10 and 30 second treatment times at a distance of 2 mm or 7 mm, showed a smoother appearance post polishing with smaller surface defects, whereas $NaHCO_3$ powder was shown known to produce large depressions on the tooth surface. This study also found similar results on nanohybrid composite with glycine powder, it was shown that glycine powder produce smaller surface defects (1 to 2 µm wide) compared to $NaHCO_3$ (5 to 10 µm wide). [69-71]

14.2 Effect on Sealants

Air polishing was found to be superior to rubber cup polishing when preparing the occlusal tooth surface prior to etching for sealants. It was also found that air polishers enhanced the bond strength of sealants compared to traditional polishing, allowing for deeper penetration of the sealant resin into the enamel surface.

According to Botti et al, air polishing was effective in plaque biofilm removal prior to sealant application.[72] Pelka et al studied substance loss caused by air polishing of fissure sealants, and concluded more surface damage was caused with $NaHCO_3$ than GPAP. This study was carried out at an angulation of 90° for 10 seconds.

In a in-vitro comparative study conducted by Engel et al, air polishing for 5 seconds on sealed teeth with $NaHCO_3$ powder caused thinning of the sealant layer and also resulted in minor defects, whereas GPAP led to less sealant abrasion. The surface defects produced by $NaHCO_3$ powder were larger in size compared to GPAP. The authors also advised to avoid air polishing post sealant application.[68]

14.3 Effect on Orthodontic Appliances

The air powder polishing is an effective means for removal of plaque in patients undergoing orthodontic treatment as it does not interfere with the wires or rubber band, orthodontic brackets and also is not detrimental to the zinc phosphate or resin cement which are used to attach brackets and bands. Debris and plaque buildup on the bracket-wire interface can result in to friction and thus affect prognosis of the orthodontic treatment. Another application for the air-powder polisher in the orthodontic practice is surface preparation of the tooth prior to placement of bracket.

It is advised to hold the air polishing nozzle approximately 4-5mm away from the tooth surface, at a 60° angle for anterior smooth surfaces, at an 80° angle for posterior smooth surfaces, and at a 90° angle for occlusal surfaces. A constant circular motion is advised for 30 to 60 seconds. [73-78] The previous review by Gutmann found air polishing to be the most efficient method for stain and plaque removal around orthodontic bands, brackets and arch wires.[79]

One disadvantage of air polishing could be higher frictional resistance on both metal and ceramic brackets. The authors concluded that air polishing with $NaHCO_3$ should be avoided for ceramic or metal brackets. There were no significant differences observed between the 2 powders, only marginal surface changes were seen on arch wire and metal brackets. $NaHCO_3$ showed roughened plastic bracket surfaces whereas GPAP did not. Therefore, glycine proved to be sufficiently effective in cleaning plastic brackets. [80]

14.4 Effect on Implants

Few studies have reported air polishing to be effective on dental implants, implant surfaces were found smooth along with inhibition of plaque. A recent study of patients with peri-implantitis found glycine powder significantly reduced bleeding on probing 6 months after treatment when comparing it to patients who were treated with mechanical debridement using curettes and chlorhexidine. Both groups had similar pocket depth reductions and clinical attachment gains 6 months after treatment. [81]

15. EFFECTS ON ENAMEL, DENTIN AND CEMENTUM

Air polishing is reported to be safe on enamel with no significant loss of enamel and a less abrasive than rubber–cup polishing. Few authors have recommended restriction of air polishing to enamel only. Enamel is minimally affected by the abrasive powder as shown with the employment of profilometer scans [Willmann et al.]. Agger et al confirmed these findings during a recent study which used scanning electron microscopy (SEM) and laser profilometry to evaluate the abrasiveness of $NaHCO_3$ on root surfaces [82-85].

Few studies reported reduction in abrasion on supragingivally exposed cementum and dentin with use of the new air polishing powders :

Tada et al studied the abrasiveness of glycine powder on dentin with particle diameters of 63 μm and 100 μm, respectively. The larger diameter powder resulted in less damage. Most recently, Tada et al studied the effect nozzle distance had on dentinal defects during air polishing. They found that employing a spray distance of 6mm from the nozzle surface of the air polisher to the dentin surface using a 45 degree angle produced the shallowest defect depths. The alternative distances examined were 2 mm, 3 mm, 4 mm and 5 mm. In addition, glycine powder (65 μm) had produced significantly smaller depth and volume defects than $NaHCO_3$ (65 μm) and another glycine powder (25 μm). Thus authors concluded that the larger particle size may not have had time to reach maximum velocity when exiting the nozzle head to strike the dentin. [86-87]

16. EFFECT ON SOFT TISSUES

Few studies indicated some incidences of gingival bleeding and a salty after taste, but no significant gingival trauma within a week or 2 after treatment.

The histological examination of healthy dog gingival tissue following an application of an air polishing with standard $NaHCO_3$ powder, revealed erosive changes in the keratin and epithelial cell layer. The extent of the damage caused was directly related with the time of exposure.

Kozlovsky et al concluded that the APD should be used no more than 5 to 10 seconds per tooth surface, with overlapping strokes to minimize the extent of epithelial erosion and to prevent the possibility of total exposure of the underlying connective tissue. [21]

5 to 20 seconds interval of air–polishing application is the working parameter used in most of the studies. Furthermore, use of GPAP has been shown to result in less gingival erosion than hand instrumentation or NaHCO3 powders when a treatment time of 5 seconds per site was used. In addition, glycine–based powder is the only abrasive that has been studied for its ability to clean plaque biofilm in subgingival pockets <5 mm. In vivo studies have indicated that it is safe and caused no substantial gingival damage.[43,88-89]

17. STUDIES DONE ON AIR-POLISHING

Petersilka GJ et al. conducted a randomized split mouth study to assess the efficacy of subgingival plaque removal in buccal and lingual sites during supportive periodontal therapy (SPT) using a novel low abrasive air-polishing powder. 27 patients on SPT were selected for the study. Subgingival debridement was performed using the novel air-polishing powder (test group) and hand instruments (positive control group). Before and immediately after treatment, subgingival plaque samples were taken from two teeth with pockets of 3-5mm depth in both the groups. Plaque samples from two untreated teeth were taken as negative control. Further, the plaque samples were assessed by anaerobic culture to determine the total number of colony forming units (CFUs). Patients perception of treatment also assessed by using a visual analogue scale (VAS). Therapy and plaque sampling were repeated at 3 month intervals. The test group results showed greater reduction in the mean CFU compared to the positive control group. The authors concluded that the novel low abrasive air-polishing powder is superior to curettes in removing subgingival plaque from pockets of 3-5mm depth in SPT. Further, the study participants found the test treatment to be significantly more pleasant than hand instruments. [43]

Pelka et al. carried out an in-vitro confocal scanning microscope study to assess influence of air polishing devices and various abrasives on flat root surface. A total of 168 teeth were assessed using 2 air polishing devices (Prophyflex 3, KaVo and EMS Handy, EMS) along with 4 powders (Air Flow Powder EMS; Cleaning Powder, KaVo; ClinPro Powder, 3M ESPE; ProphyPearls, KaVo). The authors found that the Prophyflex 3 air polishing device generated deeper defects compared to the EMS device, regardless of the abrasive used. The least amounts of defects were observed with the ClinPro powder whereas deepest defects were observed with ProphyPearls. The depth of the defects was shown to increase with increased air polishing time, also the abrasive of the tooth was dependent upon the device used, that was statistically significant. [49]

Buhler et al. conducted a systematic review on patient perception (pain, discomfort) following air powder polishing during periodontal treatment. Patient perception using a visual analogue scale was measured after air polishing with different abrasives such as sodium bicarbonate, erythritol and glycine. Patients reported lesser discomfort and pain upon when treated with erythritol and glycine air polishing powders. The authors concluded that, less discomfort was experienced upon usage of glycine containing powders during supra and subgingival non-surgical periodontal therapy. [90]

Tuchsheerer et al conducted an in-vitro study to evaluate the efficacy of surgical and non-surgical air polishing on implant surface decontamination. 180 implants were divided in to three differently angulated bone defect models (30°, 60°, 90°). Biofilm was imitated using indelible red color. 60 implants were used for each defect angulation, of which 3 groups of 20 were treated with three different glycine air powder abrasive (GAPA1-3) combinations. Further for 20 implants, a surgical and non-surgical (with/without mask) procedure was carried out. All implants were photographed to determine the uncleaned surface. Scanning electron microscope (SEM) assessment was carried out to detect any changes in surface morphology. No significant differences were found between GAPA1-3 both in the surgical and non-surgical application. The bone defect models angulated at 30°, 90° in the non-surgical air polishing group showed significant results, whereas bone defect models angulated at 60° in the surgical were significant. SEM images showed no surface damages after GAPA use. The authors thus concluded that, air polishing is an efficient, surface protective method for surgical and non-surgical implant surface decontamination in in-vitro model. [91]

Zhang Wengyi et al. conducted a randomized trial comparing clinical parameters, inflammation and microbiological outcomes of full mouth scaling with adjunctive glycine air-powder polishing. In this study, 41 patients were randomly divided in to a Control group- Group A (SRP) and test groups B1 (subgingival GPAP-Glycine air-powder polishing) and B2 (subgingival GPAP prior to SRP). Clinical examinations were performed and samples from saliva, subgingival plaque, serum and gingival crevicular fluid were collected at baseline, 6 week and 3 month. CRP, IL-6 and TNF-α were assessed from serum and GCF. Porphyromonas gingivalis, Aggregatibacter Actinomycetemcomitans and Fusobacterium nucleatum were detected in saliva and subgingival plaque samples. The control and test groups did not significantly differ by age, sex, disease severity at baseline and showed similar improvements in clinical parameters (PD, BOP, PI, GI). All groups showed similar percentage of sites with PD reduction of ≥2mm between baseline and follow-up visits. C-reactive protein, IL-6 and TNF-α levels from serum were reduced post treatment. The authors concluded, that Full-mouth SRP with and without GPAP resulted in almost similar clinical, inflammatory and microbiological outcomes in the treatment of untreated periodontitis [92].

18. HEALTH CONCERNS AND SAFETY

More recently, products have been introduced that do not contain sodium, therefore, use of these powders can be efficiently carried out on patients with sodium–restricted diet, hypertension or renal insufficiency. Products without sodium are GPAP, $CaCO3$ and $Al(OH)3$. Calcium sodium phosphosilicate powder (Sylc™; OSspray, London, UK) has a very small amount of sodium mixed with the particles and no salty aftertaste. To date there have been no medical contraindications associated with calcium sodium phosphosilicate powder, however it should be avoided for patients with silica allergies. [59]

19. CONCLUSION

New polishing powders are less abrasive and have the potential to transform the oral hygiene recall appointment for patients with minimal periodontal involvement. Thus air powder polishing can be a non-invasive option for non-surgical periodontal therapy. Future research should continue to explore ways to reduce aerosol production during air polishing, improve safety for all restorative materials and all patients, regardless of their medical condition. This review has provided evidence of the usefulness of air polishing in contemporary practice.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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