Chapter 8

Air Abrasion: Interdisciplinary Modern Technologies—Approach to Minimally Invasive Treatment of Dental Caries

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Abstract

Dental air abrasion is a minimally invasive, ultraconservative method, with indication of choice for incipient fissural caries, which still count for 90% of newly appeared caries and raise diagnosing problems of the lesional stage. In this context, the aim of the paper was to use and assess dental air abrasion as an alternative technique for the preparation of dental structures, both on extracted teeth and on patients. Bio-Art microblaster was used on 14 extracted teeth and 6 patients for the removal of fissural caries in molars and premolars. After being acquainted with the technique and according to the specific protocol of use, minimally invasive preparations were made, followed by their restoration with adhesive materials. The advantages of the method, also specified by similar surveys, were: absence of pain, vibration, noise, pressure, and heat that are generated by conventional methods (burs), leading to high acceptance by patients.

Keywords: Air abrasion, dental caries, adhesive restorations

1. Introduction

Classic/conventional decay treatment addresses the carious lesion and not the disease as an ensemble, engaging dentists in repetitive, stereotypical practice, often alien of patient psychosomatic structure. Major patient reluctance in soliciting caries treatment consisted in fear of pain, dental anesthesia, and noise generated by rotary instruments, especially high-speed handpiece [1, 2], leading to the avoidance of conventional dental treatment by almost 50% of them [1].

The remarkable progress registered in caries diagnosis tools, technologies, and restorative materials used has led to ultraconservative, minimally invasive approach in decay treatment,

with preservation of dental hard tissues (enamel, dentine) and even of affected dentine, which is capable of remineralization. Such advances have exclusively been conceivable due to consistent interdisciplinary cooperation between the field of dental medicine—that means to offer its patients the best treatment possible and the least invasive all along, and the field of applied modern technologies—which generates all the materials and equipment required for this purpose. The results of this interdisciplinary research have led to new approaches at carious disease as a whole and, concurrently, to ultraconservative attitudes. In this context, preparation of hard dental tissues benefit nowadays from alternative, "nondrill" methods, which offer special benefits, both for patients and dental practitioners, such as the following:

- Reduction of fear and increase of confidence in caries treatment
- Positive impact on patients' quality of life
- Addressability of all patient categories
- Improvement in practitioners' performance and satisfaction

The concept of minimally invasive caries treatment was introduced to dental medicine in the beginning of the 1980s through preventive resin restorations, followed in the 1990s by atraumatic restorative treatment (ART) and chemomechanical treatment (CarisolvTM). At present, new methods are available, such as air abrasion, sonoabrasion, ozone, and laser therapy [3]. Although air abrasion was first developed in the 1940s by Dr. Robert Black and improved by Dr. J. Tim Rainey, it resurfaced and grew in use barely in the 1990s, together with minimally invasive and adhesive dentistry [4, 5].

Air abrasion, as an alternative technique of cutting hard dental tissues, is an ultraconservative method in the following situations:

a. Incipient caries of pits and fissures, which are difficult to diagnose and which, despite preventive measures, still count for 90% of newly appeared caries in children and adolescents [6]. In this uncertain diagnosis [7], the practitioner may opt either to treat the lesion or only to monitor it, with questionable benefits in time [8]. In this specific lesional stage, air abrasion is the method of election, as bur preparation of pits and grooves would remove a greater quantity of healthy dental tissues as compared to air abrasion, which is more conservative [9].

If, after air abrasion removal of organic debris in pits and fissures, no decay is found, dental sealants are applied, benefiting from improved adhesion. If caries is found, the preparation is continued until complete removal of decay, with minimal loss of hard healthy tissues, being followed by preventive resin restoration.

b. In case of dental abrasion, erosion, and abfraction, air abrasion removes, without cutting dental structures, the shiny surface layer which is inappropriate for good adhesion. Thus, rough surface results [10, 11], adequate for the adhesion of restorative materials [12, 13].

c. In case of marginal repair or restoration resurfacing, air abrasion removes a small quantity of dental tissue or restoration material, respectively, increasing restoration's life span and esthetics.

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Other benefits of air abrasion caries treatment are as follows:

- It does not require dental anesthesia.
- It does not produce noise, vibrations, pressure, or heat.
- It removes only the decayed tissues with minimal loss of healthy tissues.
- It eliminates the risk of microfracture and microcrazing at the level of enamel margins.
- Dentinal tubules remain clogged after air abrasion therapy.
- It improves bond strength of restorative materials to enamel and dentin.
- The method is fast and simple—in the same dental appointment several incipient caries can be treated.

Air abrasion precautions of use during caries treatment include the following:

- It is not used in deep cavities, due to the risk of opening the dental chamber.
- It is not recommended in subgingival caries and also for removal of amalgam restorations, due to releasing mercury aerosols.
- An efficient protection is required for dental practitioners (mask, glasses, gloves) and patients (glasses).
- The risks of abrasive powder inhalation, emphysema, gingival, or smooth oral tissue lesions which might occur to patients are prevented by the use of rubber dam.
- The flow of abrasive particles and air pressure are controlled by the device; the narrow diameter of the ejecting needle, the position, and distance from where the abrasive flow is projected , all of these thus avoiding any possible accident.
- High-speed suction is required to remove the abrasive powder that accumulates during treatment.
- Patients with pathologies such as severe dust allergy, asthma, and chronic pulmonary disease should avoid air abrasion procedures [4, 5, 14, 15].

The air abrasion device resembles a small sandblaster and acts through a flow of extremely fine abrasive particles—sodium bicarbonate, aluminum/silicon oxide, bioactive glass (according to the clinical situation)—which is projected with force from the handpiece on tooth surface, by use of air or gas propulsion.

2. Aim

The practical evaluation of air abrasion technique (Bio-Art microblaster, Bio-Art, Brazil) was made in clinical applications such as fissure sealing and preparation of ultraconservative cavities.

3. Material and method

Bio-Art microblaster (Bio-Art, Brazil) is a pneumatic, portable, ergonomic, and easy to install and use air abrasion handpiece. It is specially designed for simple, small-scale clinical interventions, being practical, precise, and ensuring accuracy in use (Figure 1).

Figure 1. Bio-Art microblaster, Bio-Art, Brazil [16].

The handpiece is produced in two models:

1. The standard model, containing a fixed 138° nozzle.
2. The Plus model, containing two removable and autoclavable nozzles, mounted at 138° for anterior teeth and 90° for posterior teeth.

The equipment package contains: microblaster, quick coupling, handpiece connector, various nozzles, tank for abrasive powder, and user manual.

The aluminum oxide abrasive powder used in the survey was 75 μ grit, which was suitable for removing fissure stains and questionable incipient caries [16].

The occlusal fissures of 20 teeth (molars and premolars) were prepared (14 extracted teeth and 6 clinical cases). The following materials were used:

- 37% phosphoric acid, Rx Etchgel, Dental Life Sciences, UK
- Point 4 composite kit, Kerr, US
- Rx ColourFlow Orange, Dental Life Sciences, UK (flowable composite for restoring extracted teeth)
- Rubber dam kit, Hygenic Fiesta, Coltene, Switzerland, for isolating the operatory field in patients
- G-aenial Universal Flo A2, GC, Japan (flowable composite for restoring patients' teeth)

The following principles [14–18] were considered when using the air abrasion device:

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- The working technique should be tested on extracted teeth prior to patient application, as tactile sense is absent.
- The nozzle tip should be placed 5–10 mm far from tooth surface and slow translation moves are made [16].
- It is not recommended to insist in a single spot during preparation, as too much tooth structure will be removed.
- Frequent working pauses should be made, in order to assess the results of preparation every few seconds.
- Inspection with 5× dental magnifying glasses (loupes) is recommended, in order to assess air abrasion efficacy of cutting dental structures.

4. Results

4.1. The air abrasion preparation protocol with Bio-Art microblaster on extracted teeth consisted of the following steps [19]

- Selecting 14 teeth with fissure stains/questionable incipient caries
- Mounting the teeth in putty silicone base
- Coupling the microblaster to the dental unit
- Preparing pits and fissures by air abrasion to obtain ultraconservative cavities
- Restoring prepared cavities with flowable composite—Rx ColourFlow Orange, Dental Life Sciences, according to the protocol

The preparation and restoration of two extracted lower molars are shown: one with deep stained occlusal fissures (Figures 2–6) and the other one with fissural caries (Figures 7–11) [19].

Figure 2. Lower molar with deep, stained occlusal fissures.

Figure 3. Aspect after air abrasion.

Figure 4. Application of etching gel.

Figure 5. Application of adhesive.

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Figure 6. Restoration with Rx ColourFlow Orange.

Figure 7. Lower molar with fissural caries.

Figure 8. Aspect after air abrasion.

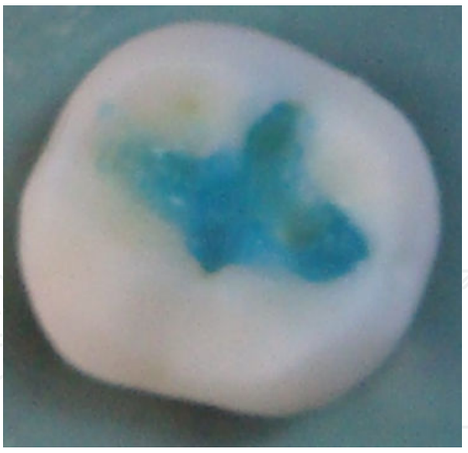

Figure 9. Application of etching gel.

Figure 10. Application of adhesive.

Figure 11. Restoration with Rx ColourFlow Orange.

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4.2. Clinical cases

Bio-Art microblaster was used in six clinical cases that displayed stains and incipient caries in the occlusal pits and fissures, according to the subsequent steps [19]:

- Coupling the microblaster to the dental unit
- Applying rubber dam
- Preparing carious lesions by air abrasion, according to the previously mentioned indications and precautions of use
- Morphofunctionally restoring of teeth according to the protocol: acid etching for 30 seconds with Rx Etchgel; application and photocuring the adhesive for 20 seconds; application, adaptation, and photocuring G-aenial Universal Flo A2 composite for 40 seconds

The sequences of clinical steps are shown in Figures 12–17 [19].

Figures 12-17. Patient I.A., 30 years old, female; Tooth 3.5 (lower premolar) displaying superficial occlusal decay. Treatment phases.

Figure 12. Lower premolar with superficial occlusal decay.

Figure 13. Air abrasion in use.

Figure 14. Aspect after air abrasion.

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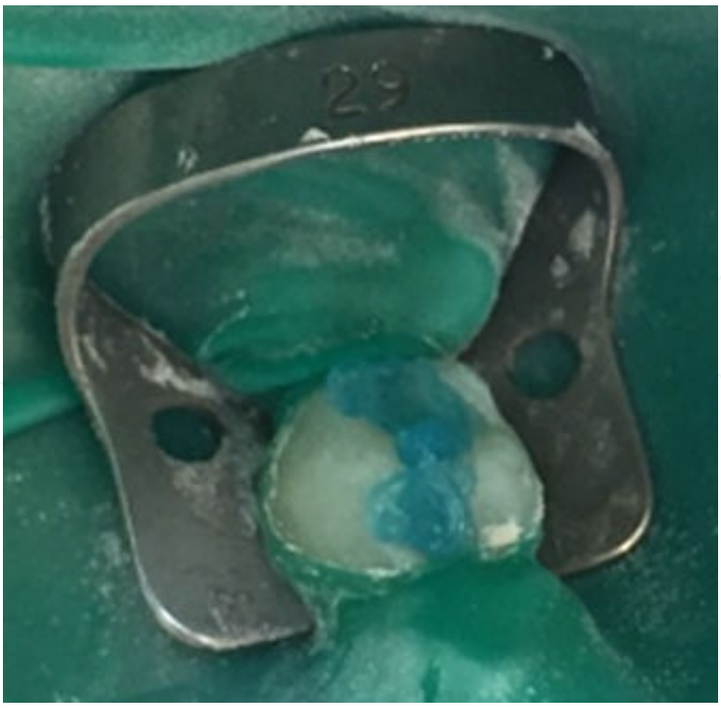

Figure 15. Application of etching gel.

Figure 16. Application of adhesive.

Figure 17. Restoration with flowable composite, G-aenial Universal Flo A2.

4.3. Another possibility of using air abrasion is adhesion improvement in view of applying orthodontic retainers [19], which is shown in Figures 18–23

Figures 18–23 show air abrasion use in view of improving orthodontic retainer adhesion.

Figure 18. Initial aspect.

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Figure 19. Air abrasion in action.

Figure 20. Aspect after air abrasion conditioning of dental surfaces.

Figure 21. Application of etching gel.

Figure 22. Application of adhesive.

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Figure 23. Final aspect, after retainer application.

5. Discussions

The appearance of adhesive materials and their increasing use has led to more conservative preparation of dental tissues. Alternative techniques to bur preparation have emerged and developed. They have the advantage of being minimally invasive, removing altered dental tissues with minimal sacrifice of sound tissues; they do not produce vibrations, noise, pressure, or heat and are well tolerated by patients, being painless in the majority of situations, thus rarely needing anesthesia. All these advantages are displayed by the air abrasion technique, which is more often used in dental practice. Research made on air abrasion assessed various aspects of its application technique. Special attention was granted to clinical, macroscopical, and microscopical evaluation of retention of various restoration materials applied on teeth prepared by air abrasion. The degree of patient acceptance and dentists' opinions on this method were also investigated.

The most important aspect of air abrasion to be considered is practicing the method on extracted teeth, prior to applying it to patients. Thus, dentists become acquainted with the method, which lacks tactile sense, and also learn to control certain parameters which influence the preparation: working distance from the operatory field, nozzle orifice diameter, air pressure in the device, abrasive particles dimensions, and flow [20]. By mastering these parameters and applying the specific protection measures recommended, efficient and safe dental preparations are obtained, leading to high acceptance by patients [2, 21, 22], as our study revealed as well. Although time spent for air abrasion therapy was found to be 1.5 higher than in case of burs, it tends to shorten as more preparations are performed [23].

Air abrasion was found suitable for diagnosing fissural caries and conditioning occlusal surfaces prior to sealant application. The results after 6 months evaluation demonstrated sealant retention in 83% of treated teeth [24]. Also, sealant retention rate was higher when applied to sound pits and fissures prepared by air abrasion and acid etching than in those prepared only by acid etching, at evaluations made after 6, 12, and 24 months following application [25]. However, another study found no statistical difference in sealant retention degree after tooth preparation by acid etching or air abrasion at 1-, 2-, and 5-year evaluations [26].

Shear bond strength of various materials applied to enamel after air abrasion was another topic investigated. Thus, Ellis et al. [27] assessed shear bond strength of sealants applied to enamel surfaces prepared by air abrasion, with and without etching with 35% phosphoric acid. Their results demonstrated that shear bond strength was greater when air abrasion was associated with acid etching.

Wright et al. [28] evaluated microleakage produced at tooth-sealant interface in three different situations: pits and fissures prepared by rotary instruments and acid etching; air abrasion preparations; and dental sealants applied after acid etching. The least microleakage appeared in bur preparation, followed by acid etching.

Borsatto et al. [29] assessed enamel shear bond strength in teeth treated by acid etching (15 seconds with 37% phosphoric acid) or by air abrasion or by combining the two methods. Survey findings were that air abrasion could not substitute acid etching, their association being needed for best results.

Abraham et al. [30] made a review of research made on nondrill methods (air abrasion, laser, and chemomechanical method) and their efficacy in treating dental decay. The study conclusions were that the alternative techniques were not superior to dental burs in removing carious lesions, although having the advantage of preserving more sound dental tissue. The duration of nondrill interventions is increased as compared to bur preparations but patients tolerate them better, especially because of the lack of pain, thus being especially useful in children and anxious patients. Other conclusions referred to the need of exercising nondrill methods on extracted teeth before being applied to patients and to the higher costs of equipment acquisition, compared to conventional rotary handpieces.

More studies are needed in order to assess all the aspects that concern the use of nondrill methods.

6. Conclusions

1. In order to assess the practical use of air abrasion with Bio-Art microblaster, the occlusal pits and fissures of 14 extracted teeth were prepared, followed by 6 clinical cases.
2. Air abrasion preparation of pits and fissures when the caries diagnosis is uncertain may lead to removal of organic debris, leaving rough enamel capable of providing adequate

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sealing. In case of fissural caries, air abrasion prepares ultraconservative, adhesive cavities, for preventive resin restorations.

3. Exercising air abrasion technique on extracted teeth is mandatory, in order to avoid useless sacrifice of healthy hard dental tissue and any other undesired side effects in patients.

4. Although preparation time takes longer than in case of burs, air abrasion technique is better accepted by patients, especially due to lack of pain; preparation time might diminish with practitioner's increase of experience.

5. Air abrasion with Bio-Art may be safely applied to patients if the protocol of use is followed and specific protection measures are taken.

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