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'AIR ABRASION'- THE ULTRA CONSERVATIVE METHOD

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ABSTRACT

Dentistry has evolved technologically rapidly all over the world transforming the dental profession. Newer concepts evolved tremendously over the decades, like tele-dentistry, virtual reality, intra oral scanning, laser dentistry, 3D printing, Digital Impressions, minimally invasive dentistry etc. The concept of Minimally Invasive Dentistry was introduced by G V Black. This is application of a systematic respect for the original tissue. The peaks of tissue preservation started embracing the minimally invasive dentistry. There are many concepts suggested by various authors. One such concept developed is Air Abrasion. The idea of abrading the tooth surface using kinetic energy causes removal of tooth surface especially in incipient lesions. This article narrates the concept of minimally invasive dentistry by air abrasion its indications, procedures, mechanism of action and, advantages of air abrasion.

1. INTRODUCTION

The minimally invasive dentistry has become quite a trend in today's clinical scenario. This idea of minimal invasion in dentistry mainly focuses on soft and hard tissue preservation and minimal intervention of clinician, and making it little less invasive.[1] The idea of minimally invasive dentistry has been introduced to the clinical dentistry in 1940's G V Black.[1] This concept was originally introduced before decades. Few concepts involve Air Abrasion, fluoride treatments, atraumatic restorative treatments, chemo mechanical ways with the idea of tissue preservation based on principles of minimally invasive dentistry.[1,2,3,4,5] During that time, this idea has become quite famous and came into practice and physicians were given special discussions about this theory.[1,6] Mc Gehee mentioned this concept in his book.[1,7] During that time, amalgam restorations were the most common. With the principles of amalgam cavity restorations, this concept of minimally invasive dentistry was given less importance. Also studies showed the dust particles that evert from this procedure harmed eyes of both clinician and patient.[8] And the removal of all the dust particles was quite difficult.[3] And the air abrasion later was redeveloped by Dr. J. Tim Rainey during 1980's[1] Air Abrasion is a pseudo-mechanical non rotary cutting and removing of hard tissue[.9]

The rebirth of the air abrasion is because of the growing trend and advancements in dentistry.[1,9] It is claimed that this procedure works on kinetic energy, air pressures and high velocity.[1,9] The terms Kinetic Cavity Preparation, Micro Air Abrasion, Intraoral air abrasion can be used inter changeablly.[3,10,11,12] Air abrasion is called as ultra

conservative method[1] The substance used for air abrasions were introduced based on different studies.

2. MECHANISM OF ACTION

The procedure is based on the air pressures, high velocity exerted by the particles and the kinetic energy.[1,2] The stream of particles mainly contain aluminium oxide.[13,14,15] The particles hit the tooth surface due to its generation or production from the compressed bottle or nitrogen gas.[2] air pressures are maintained in range between 40- 160 psi depending on the procedure.[2] It is stated that for cutting 100 psi is sufficient and for surface etching it is 80 psi.[2] A device is used to generate the particles. The flow of the particles depends on various parameters. Few stated that certain parameters include the air pressure, size of the particle, Nozzle, diameter of the nozzle, angulation, exposure time.[2] The particle size is usually maintained at 27 or 50 μm in diameter.[1,2,16,17,18] Procedure ref 16, Digital or mechanical controlling are present. The most common and standard control is mechanical. However, while using the digital control there is a consistent and shows high efficiency. The airbrator, air abrasion hand pieces, and nozzles are present. Various types of angulations are used. Three types are present with angular ranging from 0° to 120°. Commonly a 80° tip is more appropriate for preventive resin restoration. In shallow preparations, like in cervical erosions, 45° tips are more appropriate. In facial and lingual preparations, 60° tip is used because it allows the evacuation of reflected spray.

It Imparts Kinetic Energy to tiny aluminium oxide particles that are projected by a stream of compressed air or gas and expelled from small nozzle. The force generated by a relatively hard particles striking a relatively hard surface is sufficient to cut the enamel surfaces.[9]

Nozzle orifice diameters range from 200 to 800 μm. Larger nozzle orifices require higher powder flow rates and gas pressures to maintain cutting efficiency.

2.1 Uses

In case of incipient caries[1]; Pit and fissure caries[1, 20, 21]; Removal of superficial enamel defects [22]; The use of local anesthesia can be avoided due to cooling action of high pressure [22]; Stains removal 1[4,20,22]; Removal of temporary cements[14]; Class I, V, VI cavity Preparations[14]; Internal cleaning of tunnel preparations[14]; Post endodontic cavity Cleaning[23]

2.2 Advantages

Local anesthesia may be avoided[1,25,26],; High pressure air acts as natural coolant there will be no necessity of water cooling.[26]; Preservation of tooth structure[26]; No noise no vibrations[1,25,28]; Fast and simple[1,18,25]; Dentinal tubules remain clogged after the procedure[1]; Minimal loss of tooth structure1[18]; Eliminates risk of micro fractures and micro crazing while using Aeroter[1,8,25,28]; Increased longievity of the restorations.[28]; Increased patient comfort[17,29]; Reduced microleakage[30]; Less discomfort[18]; No chipping seen[18]; Less invasive18.

2.3 Disadvantage

Not very useful in removing large amalgam restorations[22]; Depth of cavity preparation cannot be controlled[22]; Accidental spillage is harmful[22]; Forms rounded cavo surface margins[22,24]; Trying to remove amalgam restoration for 1 min releases minimum mercury vapour four times than the excess of the OSHA standard[22]; Cannot be used in deep cavities with risk of accidental pulpal exposure[1,21]; Not recommended in sub gingival caries[1]; Usage of rubber dam is necessary[1]; Patients suffering from asthma, severe dust allergies and pulmonary diseases.[1]; Learning curve for dentists. They should practice on extracted teeth first[1]; Few studies reported early signs of fibrosis and emphysema due to alumina particles[31]; Not necessarily painless[21]

2.4 Contraindications

Asthma patients[24]; Chronic Pulmonary Obstructive Disease conditions[24]; Severe dust allergic conditions[24]; Recent Extractions.[24]; Recent Oral Surgeries[24]; Open wounds[24]; Advance periodontal diseases[24]; Orthodontic treatments[24]; Subgingival caries removal[24]

3. ADVANCEMENTS

3.1 Bio Active Glass

- Has relatively antibacterial properties[32]
- Has got remineralisation potential[32]
- Selective removal of softer diseased or damaged tooth structures.[32]
- Has a significant longer desensitising effect.[33]
- More acceptable patient experience[33]
- Bioactivity3[4]
- Antibacterial properties[35]

3.2 Advancements

A fluoride containing bio active glass in developed which promoted remineralisation however it is still in developmental stage[32,33]. The glasses with mixed fluoride and chloride integrate the benefits like rapid glass degradation, fast flourapatite form. It showed excellent biocompatibility and controllable hardness for effective selective cutting ability[34] Flouride content in 4SS5 help in tooth remineralization.

Zinc based glass have the potential to replace aluminium oxide as a degradable material in air abrasion technology[35]

4. SAFETY MESURES

4.1 Patient Safety

- Patients must wear protective eye glasses
- Patients must wear protective masks.
- Usage of rubber dam is compulsory
- High volume suchtion and evacuation of particles is necessary
- Soft metal matrices must be placed to avoid damage to adjacent tooth.
- Usage of disposable mouth mirrors is advisable

4.2 Doctor Safety

- Usage of protective masks
- Usage of protective eye wear
- Proper case selection
- Assistants should be provided protective masks and eye wear.

The aluminium oxide may be a hazard, proper evacuation is necessary and extra care is required in evacuation of all the particles. Suction and rubber dam is helpful[36]

Discussion

Air abrasion is a minimally invasive non-mechanical technique of tooth preparation that uses kinetic energy to remove carious tooth structure[36] air abrasion would be a part of millennial shift, where removal of decayed areas and permanent sealing makes it more advantageous[37] It may especially be used in bonded restorations[38]

These are also developed as the conventional procedures are highly disturbance to many and could create fear. So as to overcome those difficulties these advancements are developed. Various studies have been conducted to evaluate the difference in air abrasive particles on the bond strength of a ceramic to nickel- chromium alloys and cobalt- chromium alloys. These procedures can eliminate 'Drill and Fill' Dentistry.[39]

This concept of air abrasion is practiced in Paediatric patients as well. Several studies were reported. One such study is a case of six-year-old child. The cavity was restored by making the cavity using air abrasion system. Two years later, the cavity and the restoration still remained fine[40]. Several studies were conducted to determine which bonded orthodontic brackets best to the tooth. Air abrasion is done in orthodontic bonding too.[41]

Air abrasion depends on several factors. The pressure, type of particle, size, shape and nozzle tip, angle, shape. Also the quantity of particles depends on type, size and pressure applied. [46]

Few parameters are:

Size of the particle[43,44,45]; Shape of particle[46]; hardness of particle[34]; Type of particle; Diameter of Nozzle4[3,48]; Tip and Angle of tip of nozzle[49]; Air Pressure[43]

A study was conducted by Mavriqi et al., on the improvement of bio-adhesion and bond strength of glass ceramic restoration, when water- airborne-particle abrasion as a pre-treatment. The study compared the pre etching procedure with water-airborne-particle abrasion (WAPA) with the ones which are not pre etched with WAPA with a 15-Year follow up follow up. The WAPA treatment using aluminium oxide particles followed by a three- step etch and rinse adhesion system increased and improved both bio-adhesion and bond strength of 23.6% and remained for long time.[50]

The technique eliminates the needless destruction of sound tooth structures and reduces micro-leakage than in the traditional techniques of cavity preparation. Several authors showed that air abrasion acid etching is useful in reducing microleakage as well.[26, 51,52]. Cavities prepared by air abrasion were effective. A study is conducted by Ferdianakis K et al., where cavities were prepared by air abrasion technique, but restored with three different types of composite. All the cavities less or zero microleakage.[53]

A study was conducted by Zhang X et al., in which the investigated the effects of different air abrasion pressures on translucent Zirconia in terms of flexural strength and shear bond strength. 50 micrometer alumina abrasive at 0.2 MPa could achieve adequate and durable bonding.

Alumina air abrasion resulted in faster removal extrinsic stain and clinically substantial enamel removal is reduced in tooth than bioactive glass air abrasion. It was concluded in a study by Banerjee A et al.,[54]

Air flow abrasion was successful in improving the surface characteristics of titanium discs with no alteration in any surface topographic elements.[55] Pre-treatment of enamel surfaces with air abrasion increased bond strength of fissure sealant.[56] Air abrasion after laser treatment improves strength.

It is a deep learning curve to the dentists. The risk of committing error could be high initially due to lack of experience and skills. But once the clinician becomes familiar with tips and tricks, the risk of errors comparatively reduces.[57]

Drago et al., concluded that excellent antimicrobial properties without inducing resistance. High pH and osmolarity, low tissue pH is highly effective against Fusobacterium nucleatum, Porphyromonas gingivalis, and streptococcus mutans.[30,58] High Antiseptic properties are seen.[30] Milly et al., reported that usage of air abrasion with bio active glass is effective in pre cavity caries also helpful in primary prevention of caries.[30,32]

5. BIO ACTIVE GLASS

The usage of bio active glass promotes osteoconduction.[30] Air abrasion of moderately rough implant surface with bio active glasses with zinc oxide or 45S5 enhances the healing, osseointegration and bone defects regeneration.[59] Few studies showed that osteoblast cell proliferation on sand blasted and acid etched titanium discs gets enhanced with air abrasion by using 45S5 bio active glass.[60]

In dentinal hypersensitivity:
It can be used as an abrasive in a sandblaster. It causes occlusion of dentinal tubules which could reduce the permeability and in their sensitivity.[30]

Advantages

- Increased patient comfort[30]
- Reduces hypersensitivity[30]

In Orthodontic Purposes:
Limited cutting ability of the abrasive causes minimal enamel structure loss, and hence can be useful in removal of orthodontic adhesion. However, it is still in developmental stages.[30]

In Implantology
Bio active glass is useful in treatment of peri implantitis. It also enhances healing, osseointegration and bone defect regeneration.[59] It Promotes osteoconduction.3 It is also an effective technique for decontamination of dental implants as they eliminate viable bacteria from the implant surfaces.[61]

Characteristics of cavity prepared by air abrasion:

- Rounded shape[36,62]
- Halo contour[62]
- Saucer shaped cavity[62]
- Indistinct walls[62]

Advancements
Horiguchi et al., in 1988 used aluminium oxide with crushed glass powder, glass beads. In his study itself, he concluded angular shaped glass particles are more efficient than the spherical ones.[1,63] A study conducted by Banarjee A et al., in 2008 concentrated on finding the effect of powder fill on the flow rate. He used four different contours. He concluded that constant alumina level is required to maintain cutting constantly with an air pressure between 40 to 60psi.[1,64,65]

An alternative, bio active glass is developed due to the adverse effects of aluminium oxides ingestion. Studies showed that fluoridated bio glass abrasive printed remineralisation but at slower rate.[1]

The antibacterial property is studied by various people. An in vitro study to see its effectiveness on Streptococcus mutans is conducted by Abushahba et al. The biofilm on titanium implant surfaces which are sandblasted and thermal acid etched and is found to be effective against streptococcus mutans.[31]

Fluoridated bioactive glass when compared to alumina, air abrasion was significantly better, despite having lower abrasive particle output. It could be considered a plausible substitute for alumina and promotes remineralization and hydroxyflourapatite formation.[66] The glass with mixed fluorine and chlorine has excellent biocompatibility.[34] QMAT-3is a noble bio active glass can be used in orthodontic cases where selective removal of orthodontic adhesive without inducing enamel damage.[32]

Regarding safety. while usage of alumina in air abrasion studies were conducted. They were tested for cytotoxicity and apoptosis. Radziun E et al., conducted a study to check the viability of cells.[67] In such, there was no significant increase in apoptosis and no reduced cell viability is seen. Hence it has no cytotoxic effect on selected mammalian cells according to him.[67]

Air abrasion on different materials varies. Air abrasion of zirconia crowns in pre sinterd stage is not recommended as there is risk of reduced flexural strength.[68] enamel conditioning with phosphoric acid, Er:YAG lasers, air abrasion on tooth surfaces were studied by Fumes AC where phosphoric acid treatment reduced microleakage in occlusal sealants than Er:YAG lasers and air abrasion.[69]

6. CONCLUSION

Air abrasion over the decades technologically and clinically evolved. G V Black introduce the technique. Alumina was the abrasive used initially. Though it has several advantages, it had equal number of disadvantages, which was not very successful and popular then. The development of minimal intervention dentistry over the past few decades caused the air abrasion technique to resurface. Authors studied its properties, advantages and disadvantages. To overcome the disadvantages. several authors developed bio active glass. Air abrasion irrespective of ages can be used as it prepares a caviy with minimal tooth loss and mainly produces no noise and vibrations. It can be used as adjunct with restorations as it may enhance the tooth-restorative bonding. The art and knowledge in this technique allows the clinican to enhance the quality of the treatment and enhances the patient-doctor relationship as this is helpful in relieving the anxiety created by the dental procedures.

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