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Air Abrasion: Truly Minimally Invasive Technique

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ABSTRACT

Minimally invasive dentistry concept is now an essential part of dental procedures. Many novel materials and techniques have now been developed that are in line with the MI (minimal intervention) philosophy. One such technique is air abrasion. An attempt has been made in this article to cover all the aspects of air abrasion and to remove the misconceptions present about this technique.

Keywords: Air abrasion, Minimally invasive dentistry, Bioactive glasses.

INTRODUCTION

Minimally invasive dentistry is not a very new concept but still many dental practitioners do not know its importance. Many novel dental materials and techniques now work on the principle of minimal invasion. One such technique is air abrasion.

Air abrasion was first described by Black (1945).[1] His aim was to develop a technique that is effective, works on the principles of minimal invasion and is more tissue preserving.[2] During 1950s, in Michigan (USA), the air abrasion technique gained popularity and a program was designed to teach the air abrasion technique to dentists.[3] McGehee WH (1956) wrote a textbook in 1950s which even contained information about the applications of air abrasion.[4] Therefore, air abrasion is not a new technique. Since amalgam was the most popular restorative material those days, this technique did not gain much attention because it lacked the ability to accurately prepare cavity margins and there were concerns regarding the dust particles affecting the eyes of the patients and the dentists.[5] Also, the development of air turbine handpiece made cavity preparation easy and quicker.[6]

With the introduction of the minimally invasive dentistry concept, high volume suction and development of new materials that retain by bonding with the tooth tissue, air abrasion technique has experienced a rebirth.[7] Air abrasion's re-evaluation has been possible because of the change in the viewpoint of diagnosing and managing caries.[8]

Many dental practitioners are using air abrasion nowadays with 27 µm alumina particles. Air abrasion technique utilizes alumina particles for the removal of tooth tissue and it has no vibration and less heat generation, when compared with a conventional high-speed handpiece.[9]

MECHANISM OF ACTION

Air abrasion utilizes kinetic energy for the removal of caries and alumina particles which are expelled by air pressure at high velocity and the particles abrade the surface when they strike it without any significant heat or noise production.[10]

The formula for kinetic energy is $1/2\ mv^2$, where m represents mass and v represents velocity. If the surface is hard, the particles take away small amount of surface and, if it is soft, energy is captured by the material and the particles bounce off.[11]

The principal action of air abrasion is end cutting.[9] So, the access has smaller diameter but the cavities produced are deep. This action is quite different from conventional burs as they produce wider access with shallow cavities.[12] Air abrasion produces a surface roughness which is ideal for the materials that bond directly to the tooth surface.[13]

The use of air abrasion may also remove the requirement for etching the enamel surface with acid when fissure sealants are used.[14] A total of 27 µm alumina particles are only second to diamond in terms of abrasivity.[15] The hardness of the alumina particles is 16 to 18 GPa.[16]

Motisuki C et al (2006) performed a study on extracted human teeth to assess which particle size in air abrasion system removes carious dentine with maximum conservation of tooth structure. 27, 50 and 125 µm alumina particles were used and it was concluded that 27 and 50 µm alumina particles remove less sound tissue as compared with 125 µm particles, when carious dentine is removed using air abrasion.[17]

If water is added to the air abrasion system, it creates a water shroud and the water shroud not only prevents dust formation but also decreases the amount of alumina attached to the tooth surface after the procedure.[18]

Control of Cutting Efficiency

Cutting efficiency is dependent on various factors, like particle size and shape, distance of the tip of the handpiece from the tooth surface, feed rate (powder flow), length of cutting time and air pressure.[19]

Horiguchi et al (1998) used aluminum oxide powder, glass beads, crushed glass powder and crushed polycarbonate resin powder to evaluate the cutting ability of air abrasion when it was used to cut intact enamel and dentine and concluded that crushed glass powders which were angular shaped cut three times more efficiently, when compared with glass bead particles which were spherical in shape.[20]

Banarjee A et al (2008) carried out a study using four different air abrasion units to investigate the effect of powder fill on the flow rate and cutting efficiency and concluded that the flow rate was different for each air abrasion unit when the volume of alumina powder was changed. It was, therefore, proposed that a constant level of alumina powder should be maintained to attain a constant cutting.[21]

It is suggested that air pressure for tooth preparation should be between 40 to 60 psi (2.75-11.03 Bars).[22]

Alumina particle sizes for air abrasion range from 27 to 50 µm in diameter. The operating distance should be between 0.5 to 2 mm. If the distance is more than 2 mm, it results in decreased cutting.[6]

Kinetic energy of the transferred particles is decreased, when the velocity is decreased which results in reduced abrasiveness of the surface.[23] Increasing the alumina particle size (mass) from 27 to 50 µm increases the kinetic energy being transferred to the surface by a factor of 8. Although this can increase the cutting efficiency, it can also cause increased patient discomfort. Particle size of 34 µm should be used to remove enamel and 27 µm should be used to remove caries.[24]

Rotary Cutting *vs* Air Abrasion

Rafique S et al (2003) proposed that patients feel reduced pain with air abrasion as compared with other conventional methods.[25]

Rotary cutting instruments can increase the temperature of the tissue by 300 to 400ºC;[26] however, the temperature changes with air abrasion are minimum (± 2 ºC), so the risk of cracking is also decreased.[23] The shape of the bur used with high-speed handpiece is also important as, if it is less then concentric, it will cause enamel cracking.[27]

Hicks MJ et al (2001) studied the development of secondary caries after using conventional handpiece and an air abrasion technique for cavity preparation in teeth. The teeth were restored with composite resin and caries were introduced by exposing the teeth to an artificial caries medium. Polarized light microscopy was used to assess the presence and extent of the lesion and it was concluded that both techniques offer similar defence against secondary caries.[28]

Christensen (1996) compared the use of air abrasion and rotary cutting for cutting cavities in teeth and suggested that air abrasion has various advantages over rotary cutting, such as reduced noise production, no vibration and less need for anesthesia. All these advantages make this technique particularly useful for children and for the patients who have a fear of anesthesia and noise. Because of these indications, air abrasion has an edge over rotary cutting because it is in line with the principles of minimally invasive dentistry.[29]

Specific Indications of Air Abrasion Technique

Air abrasion is particularly important in certain areas. It was suggested that air abrasion can be used to diagnose and treat early lesions. It was also proposed that the cavities prepared with air abrasion are better for bonded restorations as they give rounded contours which decrease the risk of fracture of restorations.[30]

This technique is particularly useful for the removal of defects that are presented on superficial surface of enamel as it results in decreased loss of normal tooth structure when compared with a high-speed handpiece.[31]

This technique can also reduce the microleakage of the sealants because it provides a very rough enamel surface which improves the retention of bonding materials.[32]

Air abrasion can also be used to remove old restorations by increasing the air pressure.[6] When air abrasion is used, the need for local anesthesia is also minimized.[20] A total of 80 to 95% of the patients treated with air abrasion do not need anesthesia. This not only saves valuable clinical time of the practitioner but patient visits can also be decreased as multiple quadrants of patients oral cavity can be treated in a single visit. Air abrasion is very useful for the removal of composite and glass ionomer cement restorations.[31]

Cook RJ et al (2001) called air abrasion, the technique of choice for the removal of faulty composite restorations.[33]

Limitations of Air Abrasion Technique

Air abrasion is not very effective for the removal of amalgam restorations. Also, there are concerns regarding the amount of mercury released during the removal of amalgam restoration.[34] Practitioners should remain careful when they use air abrasion as there is loss of tactile sensation and it can readily cut hard tissues.[27]

Air abrasion cannot remove deep carious lesions as it cannot cut soft substances.[6]

Banerjee et al (2000) has, however, proposed that softened dentine can be removed with air abrasion, when a mixture of alumina and hydroxyapatite is used.[35]

Use of rubber dam and high vacuum suction for the patient and eye wear for the practitioner is highly recommended to prevent the dust from being inhaled and causing an injury to the eye respectively.[24]

Bioactive Glasses and Air Abrasion

Many dental practitioners are concerned about the toxicity of alumina particles which can be inhaled during the procedure.

Bioactive glasses can replace alumina in air abrasion system.[36] But bioactive glasses are brittle and they fracture after coming in contact with hard dentine surface. The hardness of bioactive glasses is less than alumina but they can cause remineralization of the surface unlike alumina. Therefore, bioactive glasses of different composition and hardness should be produced to test their cutting efficiency.[18]

CONCLUSION

Minimally invasive dentistry is the need of the hour, and air abrasion is a technique that is truly in line with the minimal intervention philosophy. Air abrasion is now being used by many dental practitioners in USA and it is still gaining popularity in Europe.

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