Minimal Intervention Dentistry : Air Abrasion

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Abstract

The age old principles that we have used for preparing teeth increasingly seem to be somewhat anachronistic, rigid and irrelevant. Instead of a mechanical or engineering approach to the subject of the tooth preparation, what is needed now is a more rational, biologically oriented approach. Minimal intervention is required to stabilize and heal an initial carious lesion; this approach will lead to optimum retention of natural tooth structure, maintaining both strength and esthetics.

Key Words: Teeth, Minimal Intervention, Estheics

Introduction

Dentistry in the past century was mainly replacement dentistry where carious lesion was treated by surgical excision. The tooth emerges through the gum, with pits and fissures that are open and incompletely sealed. Food and bacteria fill these grooves. The decay process begins and cavities take hold. The tooth gets drilled and filled and before long, refilled due to restoration failures. The main reasons for restoration failures are secondary caries and fractures, factors that are generally not addressed in the technical process of replacing a restoration. Conventional cavity designs were basically aimed at the amputation of sound tooth structure in the name of geometric perfection, in order to accommodate the short comings of restorative materials, instrumentation and operative techniques available at that time, irrespective of the size and extend of the original lesion. This traditional concept weakens the tooth physically and it has been rescheduled.

Research over the last 30 years, has made it possible to modify this approach. It is now time to encourage the profession to adopt a new overall concept called Minimal Intervention Dentistry.[1]

Concept of minimal intervention dentistry has evolved as a consequence of increased understanding of the carious process and the development of adhesive restorative materials. It is now recognized that demineralized but noncavitated enamel and dentin can be healed and that surgical approach to the treatment of a carious lesion along with "Extension for Prevention" as proposed by G.V. Black is no longer tenable.[2]

Term minimal intervention is relatively new in dentistry and has been introduced to suggest to the profession that it is time for changes in the principles of operative dentistry.

With advances in science and technology there has been-

1. An increased understanding of the chemistry and biology of caries and remineralization.
2. Development of adhesive dentistry and new materials.
3. Effective preventive strategies and fluoride revolution that have catalyzed the process of evolution in caries management.

These advances have lead to the concept of minimal intervention which is a non invasive biologically friendly approach directed towards healing of caries lesion and disease control. The ultimate goal of minimal intervention is to extend the life time of restored teeth with as little intervention as possible. It is not just a technique but it is a philosophy that challenges the old paradigm of "Extension for Prevention", developed in 1800's by Dr G V Black. Prevention and control of dental caries is through the use of simplest and least invasive procedures. The philosophy of minimal invasive dentistry or micro dentistry enables early detection. It eliminates decay at an early stage with minimally invasive therapy which maintains the integrity of the tooth.

The ultimate goal of minimal intervention is to extend the life of restored teeth with as less intervention as possible. When operative care is indicated, it should be aimed at "Prevention of Extension" rather than "Extension for Prevention".[1]

Air Abrasion Microdentistry

Air abrasion utilizes kinetic energy from alumina particles entrained in high velocity stream of air to remove tooth structure. Air abrasive methods are suited for restorations with current bonded resin materials and well into a philosophy of tooth conservation and improve the longevity of restoration.

The father of concept of air-abrasive micro dentistry is an American Dentist, Dr. J. Tim Rainey, from Refugio, Texas, USA. Dr. Rainey improved and combined this technology with the use of modern adhesive restorative material.[3]

Development of Air Abrasive Technology[4]

The instrument was first developed in the 1940's by Dr. Robert Black.

In 1951- S.S. White Technology introduced Air-Dent the first commercially available unit for preparing cavities in teeth air abrasion.

New Technology for the 1990's - Air abrasion resurfaced as an exciting "New Technology" that acts in synergy with rapid evolution of adhesive dentistry, which has changed tooth preparation requirements and eliminated the need for mechanical retention.

Air-abrasion Systems and Features[5]

Air abrasion devices include cart, table top and handheld models. Hand held devices are generally not suitable for restoration preparation but used to prepare tooth, metal, composite or porcelain surfaces for bonding. Some models have built in features and accessories, such as additional compressor, evacuation system and high intensity curing light. Operator controls are either mechanical or digital. Some systems (e.g. AIR-FLOW Prep K1) capture the Al_2O_3 powder stream in H_2O spray to reduce the pollution which increases comfort of operation.

Principle behind air abrasion is based on the formula for kinetic energy

$\mathbf{E} = \frac{1}{2} mv^2$ $\mathbf{M}$ = mass $\mathbf{V}$ = Velocity

Essentially this equation underscores the fact that the cutting capability of air abrasive is attributable to the energy of mass in motion unlike conventional mechanical methods that depend on friction.

When that rapidly moving mass strikes its target, most of its energy is transferred to that material, if that material is hard the results is removal of small amount of material. If, on the other hand the material is soft, the energy is mostly absorbed by the material and then the mass rebounds. When these highly energized abrasive particles are directed at healthy enamel, dentin the kinetic energy is absorbed by the substrate and cuts or abrades rapidly. That is why the modality is sometimes referred to as Kinetic Cavity Preparation (KCP).

Abrasive Particles

Abrasives normally employed for cutting tooth structure is Aluminium oxide, which is sharp, irregular particles, the hardness required and relatively low cost.

Alumina particles, Alpha alumina, Pure, Bio-compatible long used in medicine and food is used here. In fact it is prime ingredient in several popular tooth whitening pastes.

Depending on the nature of abrasive used this technique has ability to effectively abrade both sound enamel and dentin, but to date, these applications using commercially available alumina abrasive do not include the efficient removal of softened carious dentin. Further investigation, into the use of alternative abrasive mixture has indicated that softer particles. (e.g. Polycarbonate resin alumina-hydroxyapatite mixtures) might be more selective in removal of carious dentin, because they are only capable of removing tissue of equivalent hardness leaving healthier, sound tissue virtually unscathed.

Air Abrasion Variables[5,6]

Air abrasive units allow the clinician to focus a stream of aluminium oxide particles on a specific area of the tooth. The restorative capabilities of this technique are wide ranging and dependent on how the operator controls the following variables.

1. Pressure
2. Tip size
3. Tip angle
4. Tip distance
5. Dwell time
6. Particle size

Pressure: Most available units operate between 40-140 psi (pounds per square inch). The lowest effective pressure should be used to achieve the desired tooth preparation. For fissure cleaning prior to sealant application, a brief exposure of 40 psi is sufficient. While more extensive decay removal may require a nozzle pressure of 80 psi or more.

Tip Size : Tip aperture ranges from 0.015" to 0.027" in diameter; large tips allow more particles to pass through and are well suited for more substantial preparations, while smaller tips are used for discrete applications such as preventive resin restorations.

Tip Angle: Tip angle can range from 40° to 120° allowing access to both straight occlusal surfaces and the distolingual grooves of upper molars.

Tip Distance: By keeping the tip less than 2 mm from target surface, the clinician maximizes the focus of abrasive stream.

Dwell Time: Longer the exposure, the further the preparation will advance.

Particle Size: 27 m aluminium oxide powder is normal for intra oral procedure, 50 m powder for extra oral endeavors due to its excessive cutting and the difficulty in controlling over spray.

Scanning Electron Micrographic Effects of KCP on Human Enamel and Dentine [7]

Cavity preparations of the high speed burs had sharply defined cavosurface margins. Higher magnification revealed that the cavosurface margins showed areas of cracking and micro chipping.

KCP Preparations Demonstrated

1. Rounded cavosurface margins and internal line angles.
2. Microscopic roughness of treated enamel and dentin.
3. A halo of abraded enamel surrounding the cavity's outline.
4. Apparent closure of dentinal tubules.

Rounding of margins is caused by 'fanning' of abrasive particles as they exit the orifice. However, abrasion provided by the peripheral portion of stream is less efficient because of lower velocity and concentration of alumina particles. This phenomenon causes all internal line angles to be rounded.

The effect is minimized when tip is placed less than 1.0 mm from the tooth, where fanning is negligible. Therefore for preparation that require a beveled cavosurface margin (i.e. acid etched retained resin restoration) the instrument tip should be placed approximately 2.0 mm from the tooth surface. For restorations requiring a butt joint, the orifice should be placed approximately 0.5 mm from the tooth.

New Anatomical Structures in Teeth

Due to newly discovered anatomical structures, we are beginning to understand why over cutting teeth according to G.V.Black's principles, greatly reduces tooth strength.

In lower first molars, a sub-occlusal transverse ridge of enamel called "Rainey's Ridge" connects to other blocks of enamel to contribute to tooth strength.

In upper molars, there is similar structure of enamel called "Rainey's Web". Micro dentistry cavity design attempts to retain these structures and only remove the damaged carious enamel and dentin. The importance of conserving these anatomical structures is to retain the strength of natural tooth and to avoid the long term implications of over cutting.

Rainey Ridge: It is inter connection of distolingual cusp and mesiobuccal cusp .

Applications & Limitations of Air-Abrasion

1. Cavity preparations - Class I, V, VI
2. Internal cleaning of tunnel preparations
3. Removal of temporary cement from inside a crown
4. Micro air abrasion of white spot enamel hypoplasi
5. Stain removal
6. Preparation of metal surfaces inside a crown for better bonding.
7. Aid in repair of acrylic, composite and porcelain: the narrow cutting path and lack of vibration and heat make air abrasion technology an alternate method for these repairs.

Situations in Which Air Abrasion is not an Effective Procedure Include

1. Crown preparation
2. Large carious defects - Air abrasion is not effective for removal of gross caries because it does not effectively cut substances that are soft or resilient.
3. Amalgam removal - Air abrasion is not an efficient means of removing large amalgams especially and there is concern for the levels of mercury released when amalgam is abraded.
4. Class-II Cavity preparation-Soft materials such as carious dentin or moist and resilient decayed dentin cannot be abraded effectively with air abrasive unit. The particles tend to bounce and they do not cut effectively. Hand or rotary instruments should be use in these cases.

Advantages of Air-Abrasion

1. Non - traumatic treatment
2. Biocompatibility
3. No chipping
4. No micro fracturing
5. Decreased thermal build up
6. Micro smooth margins
7. Less invasive procedure that preserves more natural tooth structure than conventional instrumentation.
8. Greater strength and longevity because of lesser preparation.
9. No anesthesia
10. Less discomfort during preparation

Disadvantages

1. Ability to accomplish only some aspects of dentistry.
2. Lack of tactile sensation when using the air abrasion handpiece, because the nozzle of air abrasion instrument does not come in actual contact with the tooth.
3. Non contact based modality, leading to significant risk of cavity over preparation and inadequate carious dentin removal.
4. Mess and spread of aluminium oxide around the dental operatory.
5. Danger of air embolism and emphysema.
6. Impaired indirect view because abrasive particles collect on mirror rapidly blocking the viewing surfaces.
7. Damage to dental mirrors, optical devices like magnifying lopes, intraoral camera lenses or photographic equipment.

Contraindications to Air Abrasive Treatment

1. Asthma patients
2. Severe dust allergy
3. Chronic pulmonary disease
4. Recent extraction
5. Any open wounds in oral cavity
6. Sub gingival caries removal

Safety Issues [8]

1. To reduce respiratory exposure, the clinical staff should always use surgical face masks and use dry vacuum systems to reduce patient exposure.
2. Use rubber dam, protective eye glass and dead soft metal matrix to protect adjacent tooth structure.
3. Use disposable mouth mirrors.
4. Rinsing instead of rubbing the optical surfaces helps prevent scratches.
5. High speed suction and an external vacuum system are necessary to capture the powder that escapes into the air and to enhance practitioner vision and patient comfort.

Facts

1. Scientific tests showed those patients who have to undergo about 28 typical 20-30 seconds KCP preparations in older to inhale enough alpha alumina is equal to the weight of one grain of table salt.
2. Amount inhaled in a single procedure is about 1000 times less than the limit established by the occupational safety and health administration.
3. Particles inhaled are more than 10m in size and cannot enter the alveoli; they are readily swept away by the normal ciliary action.
4. Generally 10 grams of aluminium oxide is used to remove pit and fissure caries for one preparation.
5. Most preparation procedures can be easily accomplished with approximately 40-60 psi and 2.5 gr/minute powder flow.
6. Stream intensity or particle flow rate is variable from 0-8 g/min. A good standard is approximately 2 gr/min.

Available Air Abrasive Equipment

KaVo Rondo flex (KaVo, India).
KCP 100
Prestart

Conclusion

It is apparent that it is time for a change in operative dentistry. It is not possible to really imitate natural tooth structure on a long term basis, so it is best that it be retained as far as possible. Now that the profession has a better understanding of prevention of dental disease and use of fluoride, with the advent of adhesive and bioactive restorative materials, dentists should adapt to more conservative attitude to the treatment of the cavitations caused by demineralization of the tooth structure.

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