Minimally Invasive Dentistry: Air Abrasion Achieves the Reality

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Abstract

Studies have shown the inaccuracy of many of our most cherished beliefs. Newly available information and technology allows us to come closer than ever to the goal of minimally invasive dentistry. By replacing the explorer and the x-ray with the intraoral camera and air abrasion, many classes of decay can be diagnosed and treated much earlier. This article will teach the use of these new modalities to accomplish restorative dentistry in a fashion that conserves the maximum amount of healthy tooth structure. The ancillary benefits to the tooth structure and the positive patient experience are also described.

Learning Objectives

After reading this article, the reader should be able to:

- explain the basic concepts of minimally invasive dentistry.
- describe the most current understanding in caries diagnosis.
- discuss the use of the intraoral camera and air abrasion in caries diagnosis.
- reevaluate the concepts of "watch" and "incipient" caries.
- describe the use of air abrasion to perform minimally invasive cavity preparations.

As we approach the new millennium, "minimally invasive dentistry" has emerged as a new concept. However, this basic idea is as old as the Hippocratic oath. In dentistry, as in other disciplines of medicine, the overriding tenet is "first do no harm." The earlier that dentists can intervene in the disease process and the more healthy tooth structure they can save, the closer we can come to this canon.

When the practical application of this principle is considered, minimally invasive dentistry is composed of two factors: (1) the ability to diagnose a problem early, before extensive damage is done; and (2) treating the problem in a fashion that conserves natural healthy structures. These objectives require us to reevaluate our basic beliefs, criteria, and prejudices—not an easy or comfortable undertaking.

Diagnostic Beliefs

The most basic of our diagnostic beliefs is: *enamel undermined by decay will collapse.* This principle is at the heart of the diagnosis of pit-and-fissure caries with an explorer. In using this diagnostic technique, we depend on the caries to have penetrated the fissure or groove and undermine the surrounding enamel rods, causing them to collapse. This permits the explorer, which would normally be too large to enter the groove, to penetrate and "stick," which we have been taught to recognize as a caries indicator (Figure 1). The problem is that the basic principle is no longer true.

Current research has shown that despite the role fluoride has played in reducing smooth surface caries, it has had one unexpected effect. When strengthened by fluoride, enamel undermined by decay is much less likely to collapse.[1-6] The result is that caries in pits, fissures, and grooves cannot be detected reliably with an explorer.[1,3,4,7-9] In addition, recent studies have called into question the effectiveness of radiographs and other diagnostic methods in locating pit-and-fissure caries.[1,3,8-11] In one study, 100 extracted molars were evaluated for decay using a new ultrasharp explorer to probe each tooth. The teeth were then sectioned and radiographed. The result was that only 24% of the carious lesions were discovered by probing.[7]

To those of us practicing "in the trenches," sometimes personal experience brings a point home better than any research study. During my lectures, I always pose the following question: "How many of you have begun to work on what you believe to be a small area of decay in a pit or fissure, to be shocked by finding a more seriously carious tooth?" Some of these teeth, when finally excavated, end up being nothing more than a shell. Universally, the dentists in the audience indicate they have had similar experiences. If "enamel undermined by decay will collapse," as we have believed, not only would an explorer have found the problem sooner but these hollowed out teeth could not exist. They would have collapsed into craters long before this point. Even careful, caring practitioners can contribute to the problem by adhering to a "standard of care" that is no longer valid.

A New Diagnostic "Standard of Care"

There is a preponderance of evidence that diagnosing caries with only an explorer and x-rays will continue to result in missing most of the decay. Therefore, as professionals, we must change our techniques and adopt a standard of care that is supported by research and clinical findings. The combination of the intraoral camera with air abrasion dentistry has made possible a new "standard of care."[6]

The first step is examining all tooth surfaces with the intraoral camera. The ability to enlarge the image of a single tooth to 10 to 12 inches permits the clinician to observe subtle changes that would not be visible with the naked eye or loupes. Areas that exhibit changes in light transmission, color, or reflectance are recorded for further evaluation (Figures 2A and 3A). According to the literature, approximately 80% of these teeth are decayed beyond the dentoenamel junction and more than 70% are substantially decayed. The problem is that visual examination alone is unreliable, and it is not possible to tell one from the other (Figures 2B and 3B).[5,11]

After the suspect teeth are recorded, the stain and organic plug (Figure 1) are cleaned with an air abrasion device (such as KCP® 1000[a] and KCP® 100[a]) using short bursts of 27-µm food-grade alpha alumina particles at 40 psi. The choices of material and particle size are important because they are capable of removing the stain and organic plug without removing healthy enamel. Two powders are commonly used in air abrasion, 27 µm for all cavity preparations and 50 µm for adjunctive bonding enhancement applications. Other powders used by air abrasive devices may be less pure grades of aluminum oxide, which are harder and more aggressive than food-grade and, even at lower pressure, remove more tooth structure than desirable at this evaluation phase. In addition, this less pure grade alpha alumina may contain silicon dioxide, chromium dioxide, or other elements that are of questionable safety. Other authors have indicated that a sodium bicarbonate stream in either an air slurry polisher or an air abrasion device can be used.[12] This author has found this to be less successful in removing all of the organic plug and staining.

After the stain and organic plug are removed, the tooth is reexamined using the intraoral camera. If no further discoloration is present, the groove can be left alone or treated with a traditional sealant. In some states, removal of the organic plug with air abrasion can be performed by the dental hygienist after proper training. This is a very conservative and efficient way to manage this type of treatment. The hygienist can carry out the "exploration and evaluation" phase more economically and, if the dentist finds that no further treatment is necessary, dismiss the patient or place a traditional sealant.

[a] American Dental Technologies, Southfield, MI 48075

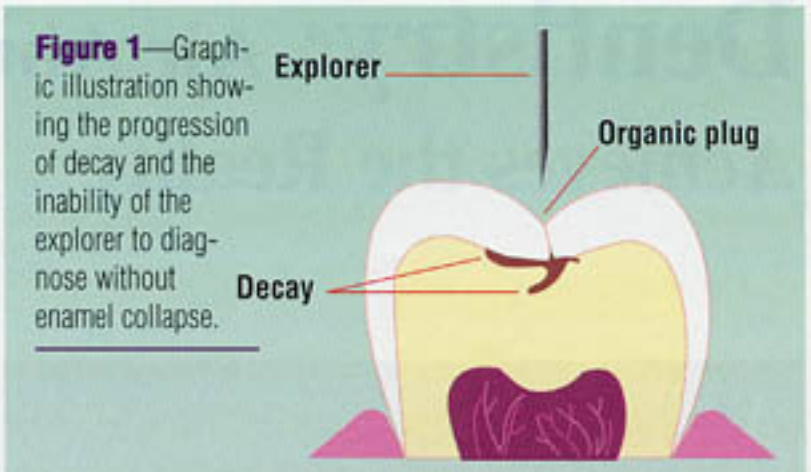

Figure 1—Graphic illustration showing the progression of decay and the inability of the explorer to diagnose without enamel collapse.

Figure 2A—Close-up of the occlusal surface showing the changes in color and reflectance under the enamel.

Figure 2B—The tooth is opened, revealing the caries.

If the discoloration extends beyond the superficial organic plug, the tooth is then diagnosed as decayed. The patient can then be treated immediately or rescheduled for further treatment. Because the tooth has not been "prepared," there is no risk of sensitivity or increased damage by postponing the procedure.

Handpiece or Air Abrasion

The question is sometimes asked whether an evaluation of pits and fissures can be done with a handpiece rather than air abrasion. A few short bursts of 27-µm food-grade alpha alumina can be used to selectively remove stain and the organic plug while affecting only a few microns of healthy enamel.[3] When using a handpiece with even the smallest diamond or bur, far more healthy tooth structure is removed, making it unsuitable for use as an evaluation instrument. In addition, scanning electron microscopy studies clearly show microfracturing and chipping of the enamel prepared with a handpiece, which are not found when a tooth is treated with air abrasion.[13] If the tooth were then found to be free of caries, the damage caused by the handpiece would most certainly not fit the "do no harm" principle.

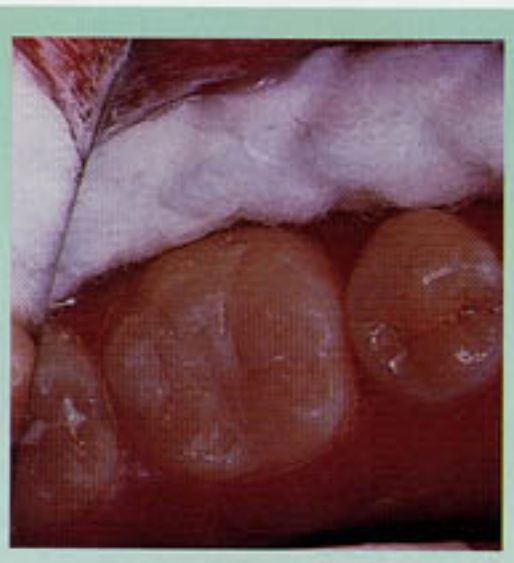

Figure 6—The sealant on the molar disguises the underlying caries. A faint change of color is visible underneath.

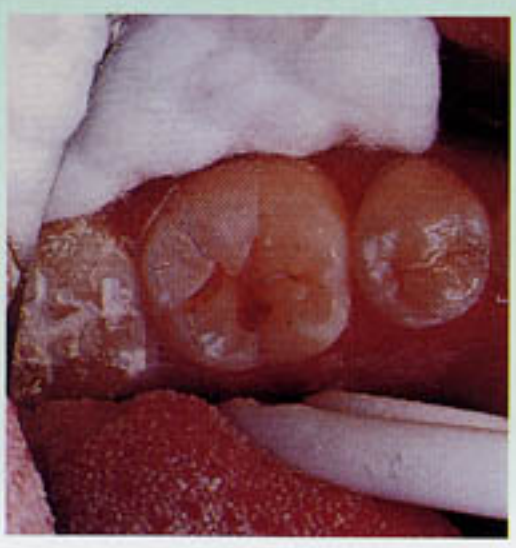

Figure 7—After removing the sealant and opening the tooth, extensive caries is visible.

still used in most dental offices and is still taught in dental schools. The well-intentioned placement of sealants on undiagnosed caries further exacerbates the problem.

Treating carious areas by removing tooth structure with a high-speed handpiece to accommodate stylized shapes determined by the physical properties of amalgam and gold removes too much healthy tooth structure and causes irreparable damage to the remaining tissues. The deficits inherent in these techniques cause us to wait until we are absolutely sure that treatment is necessary, which permits the spread of caries.

New technology has provided the means for reliably and conservatively dealing with these problems. These new modalities should become the standard in diagnosis and treatment:

- video examination of all pits, fissures, and grooves for changes in light transmission, color, or reflectance.
- air abrasion of all suspect areas at low pressure with 27-µm food-grade alpha alumina.
- exposure and staining of carious tooth structure with a propylene glycol caries indicator.
- removal of decay with air abrasion.
- restoration with a bonded composite.

Patients readily accept this new means of treatment. They appreciate that we need to "look into" the groove of a tooth before sealing it, and that we can now attack decay much earlier and more conservatively than ever before. The ability to accomplish this without injections, pain, vibration, or noise is a tremendous benefit and may result in a new source of patient referrals.

Dr. Kenneth S. Magid writes and lectures on high technology dentistry and cosmetic dentistry. He has innovated and patented many products in dentistry and is a consultant for many dental manufacturing companies (including American Dental Technologies) on new products in the "high tech" area. Dr. Magid maintains a private practice in Westchester, New York, with an emphasis on high technology dentistry.

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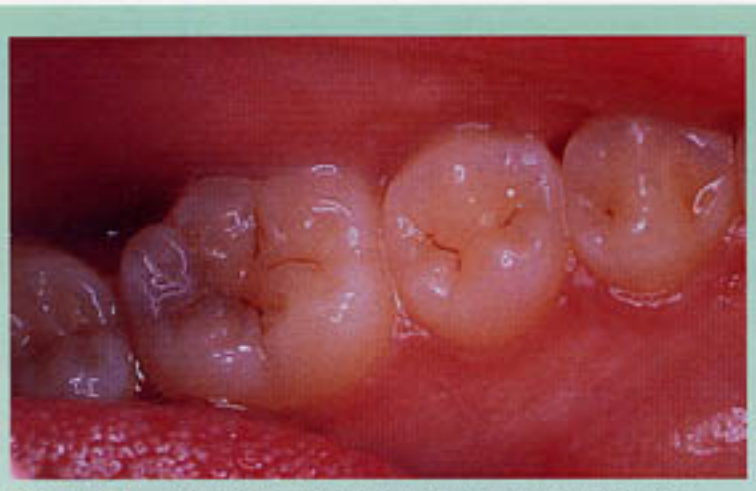

Figure 3A—The occlusal surface with changes in light transmission, color, and reflectance.

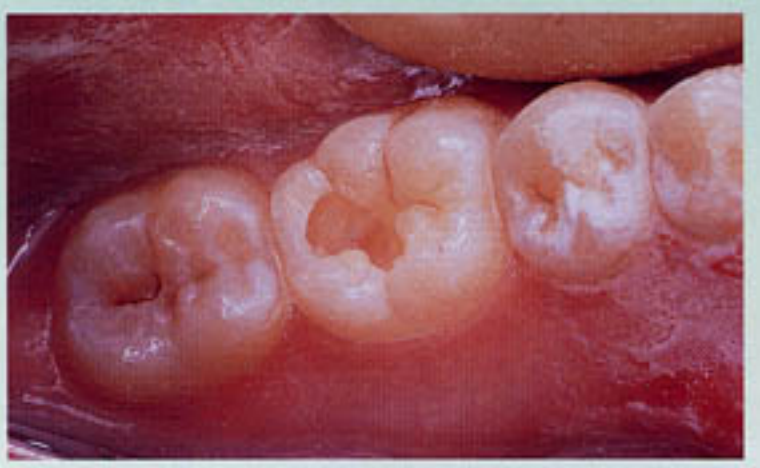

Figure 3B—After removal of decay, the extensive destruction of the tooth is revealed.

"Watch" and "Incipient Decay" Concepts

For years, dentists have labeled questionable areas as those to be "watched." Often, these areas were thought to be minimally involved and self-limiting and were referred to as "incipient decay." The belief was that the teeth were not substantially involved because there was no collapse of the enamel rods, and, if the decay progressed, it would quickly become evident by conventional diagnosis.

Historically, we have been taught it is not in our patients' best interest to remove these areas because, in treating them in the traditional fashion, the cure was worse than the disease. It is overkill to destroy almost a third of the tooth surface with a bur penetrating the dentin and causing histological changes in the pulp, creating microfractures, and then placing an ugly amalgam that may promote recurrent decay and lost cusps—all this for a little decay that may or may not be a problem. The old thought process was, "Why treat early when we can wait and watch it to see if a large carious area develops?"

We now know that the traditional clinical and radiographic indications of substantial decay are not dependable, and waiting puts the tooth at great risk. In addition, treatment with air abrasion and restoration with composite causes none of the histological changes, microfracturing, or excessive loss of tooth structure that were behind our previous decision to withhold or delay treatment.

Changing Treatment Concepts

When we have changed our diagnostic criteria to permit intervention before substantial tooth destruction occurs, we must then change our treatment concepts. As dentists, we are bound together by the influence of G.V. Black. We still follow his basic steps in operative dentistry of outline form, resistance form, retention form, convenience form, extension for prevention, and, if any decay remains after our extensive ministrations, removal of the decay. Black's teachings were ideal designs for the physical properties of amalgam and gold and the lack of substantial preventive measures. However, this treatment is anything but minimally invasive.

As we move toward minimally invasive dentistry, we must change our definition of a desirable diagnostic and restorative result. There are few of us who would look at Figures 4 and 5 and feel that the restorative result was inadequate. Although the teeth are clearly weakened and the restoration is close enough to the pulp to cause potentially irreversible pulpal changes, we see and accept this kind of result every day. However, when we put this result in the context of the patient being a 10-year-old child who has been examined by a dentist twice a year, the damage to the integrity of the tooth structure is most glaring.

The treatment steps in minimally invasive dentistry are much more limited: visualize the caries, access the decay, disclose the irreversibly affected tooth structure, remove the disclosed areas, and restore. Minimally invasive preparations do not share the architectural beauty of the line angles and bevels of which we are inordinately proud. Their beauty is in the healthy tooth structure left untouched. This, however, is a difficult adjustment to make.

Air Abrasion Dentistry

Although air abrasion can be used for treatment of Class 1 through 6 lesions, when modern diagnostic techniques are employed, most carious lesions are found in the pits, fissures, and grooves. Although occlusal surfaces constitute only 12% of the total permanent dentition surface areas, they are the sites for the development of more than 50% of the caries reported among school-age children.[14,15] This decay has not been reduced by fluoride to the same extent as smooth surface caries. In areas where water is fluoridated, fissure caries accounted for 90% of the total caries detected.[15] The conclusion of the authors who reviewed the National Institute of Dental Research studies states that "the greatest caries susceptibility of both permanent and primary teeth is in the pit-and-fissure surfaces of the molars."[16]

When a pit or fissure has been determined to be carious, air abrasion is used to access and remove the decay. Short bursts of 27-µm particles at 140 psi to 160 psi are used to carefully widen the groove. Because air abrasion cuts dentin more readily than enamel, the bursts are carefully directed to avoid creating an enamel ledge, which can create difficulties in gaining access to the decay.

After the extent of caries has been determined, the intraoral camera can be used again to involve the patient in codiagnosis and to reinforce the need for treatment.

After access to the decay is established, the pressure may be reduced to 80 psi to 100 psi. This enables more controlled removal of the decay and is more comfortable for the patient. The extent of the decay is determined using one of the commercially available caries indicators. Composed of propylene glycol with a dye medium, these stain only the irreversibly damaged outer caries. Studies by Fusayama have clearly shown that it is not possible to determine the extent of irreversibly damaged caries by color or tactile feel.[17] Carious dentin is removed with short bursts of the 27-µm particles. In using air abrasion, which removes decay and tooth structure on a much more controlled basis than a high-speed handpiece, it has been found that decay follows unusual paths, sometimes going in a lateral direction, then reversing course and proceeding underneath seemingly unaffected dentin. All areas of decay are removed, guided by repeated use of the caries indicator. Microabrasive particles will embed in very soft decay, so an excavator or low-speed handpiece may be necessary in areas with substantial soft caries.

Usually, it is not necessary to use anesthesia when treating teeth solely with air abrasion. Patients feel either nothing or tingling described as a mild "pins and needles" sensation. The lack of discomfort that might be expected when the dentin is subjected to an air stream or etching and rinsing has been attributed to the burnishing of the collagen matrix over the dentinal tubules.[18]

After all of the decay is removed, the teeth are treated with a fifth-generation bonding material according to the manufacturer's directions. The teeth can then be restored using one of the excellent composites available today. Air abrasion preparations often are so fine it is necessary to use the new generation of flowable composites that flow into the preparation without creating voids. Although some choices exist, development of a material with a higher filler load would be desirable.

Figure 4—The extensive restoration has weakened the remaining tooth structure.

Figure 5—The x-ray of the same tooth shows the proximity of the restoration to the pulp by the time the caries was detected and treated.

Sealants

Although the use of sealants has been found in the past to be a beneficial preventive measure, there are definite contraindications for placing a sealant over decay, especially when the decay extends into dentin.[19] Paterson et al noted that if shrinkage and marginal wear of the sealant produce leakage, the decay may not be detected before it reaches the pulp.[20] It is therefore absolutely necessary that we thoroughly evaluate a fissure before placing a sealant.

The use of colored/opaque sealants further impedes accurate evaluation. The progression of decay is masked under these sealants and often delays the diagnosis until substantial damage has occurred (Figures 6 and 7). The same diagnostic approach (video diagnosis and air abrasion for evaluation of any stained or discolored fissures) should be applied before placing sealants.

Summary

New technologies, such as video diagnosis, air abrasion, and bonded composites, have allowed us to best fulfill an old promise to "first do no harm." The practical application of this concept, which has come to be known as "minimally invasive dentistry," comprises two factors—the ability to diagnose a problem early, before extensive damage is done, and treating the problem in a fashion that conserves natural healthy structures.

In the area of early diagnosis, conclusive research has called for the elimination of the explorer as a primary means of diagnosing pit-and-fissure caries. It has been shown not only to be unreliable, but to promote the spread of caries and damage to enamel.[10,19] Yet, this technique is