Air abrasion was developed in the 1940s as an alternative to the slow-speed, belt-driven handpieces used at that time. The S.S. White Company introduced the Airdent air-abrasive unit in 1951. The technology enjoyed a brief period of popularity due to its patient-friendly aspects: no heat, vibration or bone-conducted noise. The arrival of the Borden air rotor, the first air turbine handpiece, in the late 1950s, however, quickly replaced alternatives such as the Airdent.

Since its recent re-emergence, air-abrasive technology again offers an alternative to conventional handpieces. Using a pressurized stream of microscopic non-toxic abrasive powder, the technology provides a new means for rapidly removing enamel, dentin, decay and previous restorations. Although not appropriate for every clinical situation, the air-abrasive system offers several advantages over conventional handpieces. For example, the air-abrasive system minimizes heat, vibration and bone-conducted noise associated with conventional means of caries removal since the cutting is accomplished by air pressure. Also, patients treated with the air-abrasion system rarely request anesthesia.

National Institute of Dental Research surveys indicate that the incidence of pit and fissure caries constitutes a higher proportion of the total caries incidence among U.S. teens and children than in the past. Air-abrasive technology may provide a more conservative alternative in the diagnosis and treatment of pit and fissure caries than traditional techniques using handpieces. The authors review characteristics of pit and fissure lesions and discuss methods for diagnosing and treating these lesions using air-abrasive technology.

The air-abrasive system uses a narrowly focused particle stream that abrades tooth structure in proportion to the particle size, air pressure and nozzle distance employed. Therefore, this newly revived technology may provide a more conservative means of diagnosing and treating pit and fissure caries than conventional methods. Exploring new avenues of addressing pit and fissure caries is particularly important now because recent surveys indicate that the incidence of pit and fissure caries has become a higher proportion of the total caries incidence among U.S. teens and children.

This article reviews the characteristics of pit and fissure lesions and introduces methods to detect and treat pit and fissure caries with air-abrasive technology.

PIT AND FISSURE CARIES

Changing patterns of dental caries suggest the need for a new emphasis on diagnosing and treating pit and fissure caries. By 1985, Ripa noted that although occlusal surfaces constitute only 12 percent of the total permanent dentition surface area, they are the sites for the development of more than 50 percent of the caries reported among school-age children. This high rate may reflect the dramatic decline in the incidence of smooth-surface caries noted by Hicks in his discussion of sealants and caries-preventive resins. Pit and fissure caries, however, has not proportionally decreased in incidence and therefore has become a more significant problem. A national study of more than 30,000 school-age children dramatically documents this shift.
In addition, researchers have begun to re-evaluate the methods used to detect pit and fissure lesions; specifically, they question the traditional use of the explorer to probe for caries. Enamel undermined by carious dentin but strengthened by fluorides appears less likely to fracture and collapse than non-fluoridated enamel, making detection of underlying diseased dentin difficult (Figure 1). Additional reports scrutinize the effectiveness of radiographs and other diagnostic methods in diagnosing pit and fissure caries. Difficulty in distinguishing a stain on the surface from a darker-colored organic plug within the pit or fissure that can promote caries also contributes to the diagnostic dilemma.

**AIR-ABRASIVE TECHNOLOGY**

Air-abrasive technology offers new options in caries diagnosis and restoration. The scouring action of the air-abrasive method can clean out both stains and organic debris in preparation for sealant application and can open areas of early caries for replacement with resin restorative materials. This article will present methods of both diagnosis and treatment of pit and fissure caries employing air-abrasive technology.

**AIR-ABRASIVE METHODS**

Air-abrasive technology provides a new approach to diagnosing pit and fissure caries. This method is of particular advantage in examining darkened areas in the bottom of pits and grooves. If a suspicious darkened area is detected on visual examination, the air-abrasive system can deliver one or more short bursts of alpha alumina powder into the pit or groove. If the darkened material is simply a stain or the organic plug, this abrasive action will quickly eradicate it while leaving all but a few microns of healthy tooth structure intact.

Frequently, short bursts from the air-abrasive instrument reveal underlying decay that had been masked by the stain. This previously undetected decay may even penetrate into the dentin. Further bursts of the abrasive powder stream may be used to completely eradicate these dark, carious veins until only lighter-colored healthy tooth structure remains. Because the dentist controls the duration and range of these bursts, he or she is able to remove tiny amounts of material at a time, preserving a maximum amount of healthy tooth structure. The air-abrasive technique roughens the tooth surface, leaving it suitable for direct bonding techniques without acid etching. Carious dentin can be removed by additional bursts.
An air-abrasive preparation can be restored immediately with either a filled or an unfilled composite resin. If the grooves are shallow and little or no tooth structure is eliminated, a sealant may be appropriate. If the anatomy is irregular or decay had been present and tooth structure had to be removed, the lost material should be replaced with a bonded, filled resin and the restored tooth recontoured. Smaller secondary grooves may then be covered with sealant, creating a preventive resin restoration. 26-31 If the caries extends beyond the enamel into the dentin, a glass ionomer liner should be placed before the composite and the sealant. 19 Further, authors of one article recommended use of a laminate restoration consisting of a composite resin sandwiched between a glass ionomer liner as well as use of a covering sealant if the finished restoration will be subject to occlusal stress. 19 These restorations can be completed quickly and conveniently using air abrasion because this technology does not require liquid cooling or acid rinses and, therefore, allows the dentist to work in an entirely dry field.

This device is not well-suited for removing all decay, however. Moist and resilient decayed dentin cannot be abraded effectively with the air-abrasion unit. The particles tend to bounce, and they do not cut efficiently. Hand or rotary instrumentation should be used in these cases. Air-abrasion devices also cut dentin more readily than enamel, which allows overhanging enamel to develop. To avoid overextension in dentin, clinicians may need to trim the enamel margins with a rotary instrument. Larger restorative preparations may require the use of a combination of techniques.

DISCUSSION

The air-abrasive technique provides an alternative to the traditional method of diagnosing and treating fissure caries that offers a number of advantages. For example, more accurate diagnosis with immediate cavity preparation is possible with the air-abrasion system. The process could start with the hygienist, who should carefully examine the teeth for darkened areas in the bottom of pits and grooves. If available, an air-slurry polisher can be used with a sodium-bicarbonate slurry to remove most stains if no decay is present. The dentist should do a follow-up examination of any darkened area that is not removed by the sodium-bicarbonate slurry.

The traditional means of diagnosing caries has included use of the explorer and radiography. However, researchers have questioned the validity of both these methods in recent years. A sticky fissure detected by the wedging of an explorer tip is no longer considered a reliable sign of caries 12-19 (Figure 2). Probing of pits and fissures also has been de-emphasized because of its potential for damaging enamel. 15-17 Likewise, reports indicate that radiographs often fail to detect caries in the early stages. 12,13 Instead, studies suggest that careful visual inspection of an air-dried tooth surface is most revealing. 18,22 Introra oral video cameras can facilitate the viewing of caries in grooves that are too narrow for the penetration of an explorer tip. Any defects that are detected can be opened up and cleaned out using the air-abrasive system, revealing the true carious nature of the area beneath the organic plug.
plied over caries and carefully monitored, they are effective in arresting the disease.\textsuperscript{34-37} Unfortunately, shrinkage and marginal wear commonly lead to leakage. In “Modern Concepts in the Diagnosis and Treatment of Fissure Caries,” Paterson and others noted, “If such leakage occurs over active dentinal caries, it may not be detected before pulpal involvement or extensive undermining of enamel and/or cuspal fracture occurs.”\textsuperscript{19} This same risk of leakage and the reactivation of decay also is a concern when sealing over decayed enamel.\textsuperscript{33} By employing air abrasion to clean and reveal decay, this can be avoided.

From the patient’s point of view, air-abrasive technology offers advantages. Patients readily appreciate the concept of conserving healthy tooth structure by attacking decay at the earliest possible moment. Psychologically, they also may feel better about maintaining teeth that have been restored to a natural, healthy appearance, rather than restored teeth that retain unsightly stains around the restoration. Since the air-abrasive system usually allows the procedure to be performed without anesthesia, vibration and annoying sounds, patients view the service as extremely valuable.

Five air-abrasive units currently are being marketed: the three KCP series (KCP 1000 Whisperjet, KCP 2000 and KCP 2000 Plus; American Dental Technologies), the MicroPrep (Sunrise Technologies) and the Kreativ (Kreative Inc.). With any new technology, cost becomes a factor. Currently, the air-abrasive units range in price from $7,995 to $16,900, depending on the features, the accessories and the model. Under a lease plan, a typical air-abrasive unit costs between $300 and $400 per month, or about $15 to $20 per working day.

Expense reductions can offset this investment by reducing the use of prophylactic paste, disposable prophylactic angles or rubber cups and brushes. The tubular handpiece of the air-abrasive unit can be sterilized by bagging and autoclaving, and it does not require the labor-intensive lubrication and processing needed for high-torque/low-speed and air-rotor handpieces. Fewer burs, anesthetic cartridges and topical preparations also are used when the air-abrasive system is employed, further reducing expenses. Faster working times mean more accomplished at each sitting, increasing patient satisfaction. Faster working times also translate into more patient visits per day.

Researchers’ interests have
also been piqued by the re-entry of this technology into dentistry. Initial studies using the technology with bonded resin materials have been encouraging.\textsuperscript{22-24} Further studies of microleakage and bond strength are needed. Studies evaluating dentin bonding after air-abrasive preparation vs. conventional acid etching have been favorable but also variable and require further research.\textsuperscript{22-24,38-40}

Technique variations may reveal even more effective and efficient procedures with this new technology. Future air-abrasive equipment may incorporate improvements.

Currently, the size of the available units is somewhat intrusive in smaller operatories. Also, the nozzle tip requires frequent monitoring for wear, but more resistant material could be found that would increase the nozzle tips’ durability. Because the future of air abrasion seems secure, further improvements are inevitable.

**SUMMARY**

Pit and fissure caries poses one of the most serious threats to the dental health of our next generation of patients. Air-abrasive technology may provide a useful method to help meet that threat head on.

In brief, the steps in the air-abrasive approach to diagnosis and treatment of pit and fissure caries are:

- visually detecting suspiciously stained pits or fissures;
- removing stain with an air-abrasive stream;
- evaluating the pit or fissure for decay;
- if no decay is present, sealing the pit or fissure with resin materials;
- if caries is present, complete-

Dr. Goldstein is a clinical professor, Department of Oral Rehabilitation, Medical College of Georgia, School of Dentistry, Augusta. Address reprint requests to Dr. Goldstein, West Paces Professional Park, 1216 West Paces Ferry Road, Suite No. 200, Atlanta.

Dr. Parkins is professor of pediatric dentistry, School of Dentistry, University of Louisville, Louisville, Ky.

ly eradicating the decay using the air-abrasive stream (hand or rotary instruments may be used if the area of decay is large);

- depending on the extent of decay, restoring with glass ionomer cement, an adhesive bonding agent, composite resin or sealant, or an additive combination of materials.

In many cases, the air-abrasive approach allows for the discovery and treatment of decay that was difficult to detect by other means. Patients appreciate the comfort of this approach to the early interception of decay. Air-abrasive technology provides a promising addition to available preventive and conservative methods for surface preparation and removal of stain or decay. Long-term clinical observations with these methods are needed.

The opinions expressed or implied are strictly those of the authors and do not necessarily reflect the opinions or official policies of the American Dental Association or its subsidiaries.

Both authors have served as consultants or received educational and research funding from American Dental Technologies and SunRise Technologies, both manufacturers of air-abrasive systems; however, neither author has any financial interest in any company or air-abrasive system. Likewise, neither the American Dental Association nor its subsidiaries has any financial interest in the products mentioned in this article.

and dentin (Abstract no. 1,457). J Dent Res 1993;72 (Special Issue);283.