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Contemporary Treatment of Incipient Caries and the Rationale for Conservative Operative Techniques

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The traditional teaching of cavity preparation design still follows the principles described by Black [1,2]. Despite many practitioners stating that, for the most part, they have abandoned "extension for prevention," many of Black's foundations are still espoused [1], perhaps owing to a reluctance to discard ingrained fundamentals until newer techniques have been verified through research. This article provides evidence to support the use of more conservative cavity preparation techniques with adhesive restorative resins and addresses the issue of conservative operative techniques as they relate to hidden or occult caries. The support for contemporary technology also concerns methods of caries detection and the role of magnification, caries risk assessment of the patient, conservative caries management, instrumentation, materials, and techniques.

Hidden caries

The diagnosis of occlusal caries has become more complex in the past 30 years, possibly owing to the increased use of fluoride [3–5]. All carious lesions are considered to be in a dynamic state of demineralization and remineralization [6], with fluoride having a well-established role in enhancing

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the remineralization process [7–9]. Fluoride may perform its job too well by causing the enamel at the entrance of a fissure to remineralize, trapping decay below [4,5,10]. Although estimates vary, studies have shown that 15% to 33% of teeth deemed clinically sound are found to have hidden trapped decay on histologic examination [3,10]. Although some of the decay in these studies could be seen radiographically, in many cases it was not evident, leading some investigators to posit the limited value of bite-wing radiographs in the detection of occlusal caries [11–14]. Bite-wing radiographs seem to have more value when used to determine the presence of interproximal decay or heavily infected occlusal lesions [7,14,15].

Caries detection

To accomplish minimally invasive dentistry, carious lesions must be detected at the earliest possible time [1]. If detected in the early stages, carious progression can be arrested, avoiding a more invasive operative intervention [16]. Accurate diagnosis of the noncavitated lesion is important because an increased prevalence may be an indicator of high caries activity, a condition that should be dealt with by using a more aggressive preventive program [7].

The traditional tool for pit and fissure caries detection has been the explorer or occlusal probe; however, in recent studies, use of the explorer has lost favor because it may create an opening through which cariogenic microbes may penetrate as well as carrying caries-producing bacteria from an infected tooth to one that is uninfected [2,17,18]. Furthermore, there is no overall improvement in the accuracy of diagnosis with a probe when compared with astute visual examination accomplished with careful drying, good light, and magnification [1,2,19–21].

Several new technologies seem to be more promising for detecting hidden and incipient caries. From noninvasive to slightly invasive, these new devices include quantified light-induced fluorescence (QLF), optical coherence tomography (OCT), laser fiberoptic transillumination, the operative microscope, and operative exploration of the fissure or pit using air abrasion, water lasers, and fissurotomy burs.

QLF causes the carious lesion to appear as a different color [22]. Clinically, QLF will typically show demineralization or incipient lesions as a dark spot [22]. Caries and plaque appear red in color, indicating a bacterial presence [22]. For the patient, the differences in color can be motivational because the invasion of bacteria is obvious and dramatic. For the clinician, QLF is a viable tool not only for detecting decay and open margins but also for monitoring the progression of demineralization [22]. In conjunction with the operative microscope, some consider laser fluorescence to be the most consistent method for diagnosing pit and fissure caries [23].

OCT uses broad bandwidth light sources and advanced fiberoptics to achieve images [24]. Similar to ultrasound, OCT uses reflections of near infrared light to determine not only the presence of decay but also the depth of caries progression, an achievement that other tools cannot boast [24].

Laser fiberoptic transillumination is advised for use in conjunction with magnification and careful visual examination [15,25] because there is a high degree of correlation between visual detection and high scores for the laser fiberoptic tool. Accuracy is not as predictable for demonstrating lesion depth [25]; however, the laser is still an excellent adjunctive tool upon which to base decisions concerning the necessity for the possible excavation of a fissure or pit [1,23,26].

The combination of careful visual assessment, patient factors (eg, caries risk), and the appearance of a possible lesion on radiographs is the next level of caries diagnosis, especially in instances of increased caries infection [27]. Although visual inspection is not indicative of the level of infected dentin [27], transillumination with a bright light source and the use of magnification may reveal a suspicious fissure or the presence of enamel cracks [28]. Most enamel displays varying forms of enamel cracks or crazing owing to constant temperature variations. Of concern are cracks that are stained and must be considered permeable or permeated [28]. Cracks that show shadowing require treatment by a tunnel preparation or some other form of conservative intervention followed by a glass-ionomer restoration or some other type of restorative material that releases fluoride ions [28].

The final level of caries diagnosis involves conservative operative exploration. It is clinically acceptable to explore occlusal fissures and pits using hard-tissue lasers, air abrasion, sonoabrasion, fissurotomy burs, and very small round or inverted cone burs (no. ¼ round or no. 33½) [1,9,19,20,29,30]. The intent is to remove or debride the organic plug [21], allowing clear visualization of the debrided fissure or pit. Afterward, the clinician must decide how to proceed with caries management based on the patient's risk assessment.

Risk assessment

Assessing the risk for caries infection gives the clinician a basis upon which to respond and is part of a commitment to preservative as well as conservative dentistry [7]. Determining a treatment regimen based on risk levels yields a greater probability of success as well as ensuring cost effectiveness [31]. The overall caries rate in this country is declining [32], possibly owing to fluoride in public water systems, fluoride dentifrices, and in-office fluoride treatments [33,34]. Research also suggests that the progression of the carious process through enamel is slower than previously believed [33,35]; therefore, a determination must be made as to whether the patient is high or low risk.

High-risk factors include the frequent ingestion of snack foods and soft drinks or juices, poor hygiene [36], and a lack of fluoride in the water system

[37]. Moreover, the presence of an active lesion in the mouth is thought by some practitioners to be the best predictor of a high-risk status [6]. Caries risk, regardless of age, should be a primary reason for sealant placement [9]. In a child 6 years of age or younger or an adult with xerostomia, it is wise to consider a policy of sealants in pits and fissures as a preventive measure if the patient is high to moderate risk and as a therapeutic measure if incipient caries is evident [9].

One should chart all pathology and assess the caries risk to decide on the time of intervention [16]. Having determined a low-caries risk may require an even greater vigilance to ensure that the established risk level is accurate [36]. The pits and fissures of the occlusal groove system remain the most susceptible location for caries [10], and a continuous assessment of these locations in the mouth is essential. Remineralization is possible in a patient who is compliant with a prescribed oral hygiene regimen, but, at some point, a decision must be made regarding the option of an observation protocol or surgical intervention [9]. Ultimately, failing to diagnose caries is a far greater omission than overtreatment of incipient lesions [21].

Caries management

As implied previously, the most important data on a patient, and that dictating a plan of treatment, is the number of active lesions in the mouth [36]. In the absence of active lesions but with the presence of incipient caries, a watch and see approach may be appropriate. If the patient is considered to be at a higher risk, a regimen of fluoride toothpaste twice daily, a fluoride rinse at bedtime, a chlorhexidine rinse once per week, and in-office fluoride treatments twice yearly is an acceptable protocol [7]. For high-risk patients younger than 6 years, a 3-month recall for in-office fluoride treatment may be more appropriate, especially owing to the observation that topical fluoride is more effective on newly erupted teeth than those present in the mouth for several years [38]. Additional interventions that need to be considered are nutritional and oral health counseling [9], as well as the use of chlorhexidine or fluoride varnishes [7,8,39], especially in areas of demineralization or increased risk (eg, around orthodontic brackets).

The disadvantage of proceeding with an operative procedure in the early stage of decay is the elimination of the chance that incipient lesions may remineralize or arrest [40]. Once restored, sealants and preventive resin restorations (PRRs) must be maintained carefully and monitored for leakage [40]. Nevertheless, one study found that, when compared with sound permanent first molars, fully sealed permanent first molars had a 75% lower incidence of the need for new restorations [41]. Clearly, erring on the side of prevention is a safe course. An incidence of 15% to 33% of hidden caries is considered a strong indication that the US policy of sealing all occlusal surfaces soon after eruption is appropriate [3,10] and is considered by some to be a form of immunization against caries [1].

Although some researchers believe that initial penetration of the dentinoenamel junction should not be an automatic justification for operative intervention [11], many others concur that breach of this junction is a clear determinant that surgical intervention is required [42–44]. Opinions vary as to whether caries will become inactive if adequately sealed from the hostile environment of a caries-prone mouth [2,3]. The possibility that dentin under sealants may not become inactive strengthens the practice of considering all hidden caries beneath intact enamel as active, with the need to remove it and to restore the tooth conservatively [21,42–44].

Instrumentation

Contrary to Black's principles, contemporary thought is that the inadvertent sacrifice of sound tooth structure impedes the progress of achieving truly conservative dentistry [19]. Many technologic advances allow the progressive clinician to attain conservative hard-tissue removal. Traditional instrumentation includes small round or inverted cone burs (no. $\frac{1}{4}$ round or no. 33$\frac{1}{2}$) that can be used to remove the organic plug of a fissure or pit [9,20]. The newer and more conservative fissurotomy burs also accomplish this goal [1,21].

Air abrasion, sonoabrasion, and the Waterlase (Biolase, San Clemente, California) are other popular choices for fissure and pit exploration [1,20,21,29]. Although all of these methods are considered equally effective, one study found that sonoabrasion removed the smear layer, whereas hand excavation, bur excavation, and air abrasion did not [29]. Laser ablation and chemomechanical caries removal (such as with Carisolv [MediTeam Dental AB, Goteborg, Sweden]) were determined to be almost as effective [29,45]. Another study determined that using a hard-tissue laser to prepare fissures and pits resulted in a higher tensile strength of the ensuing restoration in a comparison with air abrasion [30].

If, upon exploration of the fissure, it is determined that hidden caries is indeed present, conservative removal is advocated. Polymer caries removal burs are an excellent choice for this task [19]. Instead of a metal body and cutting blades, polymer caries removal burs have a metal shaft and polymer blades. Diseased dentin has a Knoop hardness rating of 0 to 30. Healthy dentin is 70 to 90 Knoop and enamel 360 to 430 Knoop [19]. Polymer blades have a Knoop hardness of 50; therefore, only diseased dentin will be removed, leaving the healthy tooth structure that will effectively resist the action of a polymer-cutting instrument [19]. Chemomechanical techniques can also be employed for conservative caries removal and may not require anesthesia [45]. Once debridement is complete, restoration can be completed.

Materials

Minimally invasive restorative materials include pit and fissure sealants, flowable composites, resin-based composites, glass ionomer, and conservatively prepared and sealed amalgams [1,2,19,20,36]. A reassuring consideration of resin restorations is that the bonding agents currently used are nearly as strong as natural tooth structure [1]. Seventh-generation adhesives are not as moisture sensitive as earlier adhesives, and moisture may even increase the retention of sealants [19,30].

If exploration of the fissure or pit results in an excavated area that might best be served by placing a resin-based composite, a novel approach is to etch, rinse, and dry the area, followed by placement of a sealant to penetrate the tooth surface for 10 to 15 seconds in the absence of light. Composite is then compressed into the fissure or pit with a small ball-burnisher to improve penetration not only of the sealant but of the resin as well. The composite is followed by light curing for at least 40 seconds [20].

In posterior areas of the mouth, patients with active lesions are not considered to be candidates for resin-based restorations because plaque is more likely to adhere to composite resins [7]. Instead, conservative amalgam restorations are placed following caries debridement and then sealed with unfilled sealants [2]. Existing posterior composites can also be protectively sealed with unfilled sealant, a procedure that has been observed to protect posterior resin restorations from wear [2].

Magnification

The important role of magnification has already been established throughout this review. The observation of narrow fissures, small pits, and the open margins of existing sealants or other restorations would be difficult at best without the aid of magnification. Some skilled clinicians can perform microdentistry with traditional loupes (2.5×) and good transillumination [9,19–21]. Others prefer the more progressive approach of using an operating microscope or 5× loupes that enable the visualization of small cracks, holes, air bubbles, open margins, and areas where bonding agent was not applied properly [1]. The use of magnification with the aid of excellent illumination may help eliminate the reliance of the watch and see approach [21].

Contemporary cavity preparation and restoration

Although the incidence of caries is decreasing on interproximal surfaces, occlusal pit and fissure caries continue to increase [46,47]. In general, caries on occlusal and buccal/lingual surfaces account for almost 90% of caries experienced in children and adolescents [48]. This high rate of caries relates specifically to the pit and fissure morphology of occlusal and buccal/lingual surfaces that is not affected by the caries-preventive effects of systemic and topical fluorides. Using a dental mirror and explorer during a clinical examination, the clinician can make the observation that there are pits, fissures, and grooves on the surfaces of teeth. Nevertheless, the diagnosis of carious pits and fissures can often be daunting, especially with recent changes in the diagnosis and treatment of caries [49,50].

Historically, the earliest minimally invasive treatment of suspected pit and fissure caries has been referred to a prophylactic odontotomy [51]. Hyatt [52] described this preventive and prophylactic procedure in which at-risk pits and fissures were minimally prepared with small burs and restored with amalgam before visible attack by caries. He referred to prophylactic odontotomy as the preferred treatment method for children because it conserved tooth structure.

Almost 70 years since Hyatt's description of minimally invasive cavity preparation, it has been accepted that the primary goal when treating a carious lesion is maintenance of as much tooth structure as possible combined with the placement of a restoration that is durable. In a minimally invasive lesion, several different treatment modalities can be employed. The removal of tooth structure to treat caries has traditionally been accomplished with air-driven, high-speed handpieces with dental burs of different geometric shapes and designs. The goals have always been to open the cavity preparation to visualize the caries and to prepare the tooth to receive the restorative material selected. In minimally invasive carious lesions, the traditional cavity preparation that fulfilled the concept of extension for prevention by including all pits and fissures as part of the preparation has changed to preparation designs that focus on the elimination of the infected tooth structure using small burs, air abrasion, or, in some cases, lasers. The preparation for these minimally invasive lesions extends barely into dentin, and, in some cases, only the carious enamel needs removal [53]. These smaller preparations may provide an additional diagnostic tool to evaluate the extension of caries. As described earlier, with the use of fluoride, the characteristic demineralization and carious lesion of enamel may be absent, and minimal opening of the enamel lesion may reveal the presence of caries. These lesions have been referred to as "hidden" caries.

In 1978 Simonsen [54] described a minimally invasive preparation using small burs in which the tooth was restored using a combined adhesive-composite, resin-sealant technique that he named preventive resin restoration (PRR). Later reports demonstrated the clinical success of these conservative restorations [55]. Today, with the introduction of less viscous, wear-resistant composite resins, that is, flowable composite resins, the PRR can be accomplished in a more simplified restorative technique [56,57]. Flowable composites offer the advantage of needle tip placement into the small conservative preparations of PRRs; however, they do not have the same depth of cure as other restorative composite resins. They require incremental placement at a thickness of 2 mm and light curing of 10 seconds with a quartz halogen curing light or LED curing light with a light energy emission of 600 mW/cm^2. Plasma arc curing lights should have a curing time of 5 seconds [57]. As described in the literature review, better diagnosis of occlusal caries combined with the ease of filling minimally invasive preparations with flowable composites has led to changes and improvements in preparation techniques to keep the preparation size conservative.

Air abrasion for cavity preparation in preventive resin restorations

The concept of air abrasion directing a high-velocity abrasive particle at the tooth structure for cavity preparation is not a new technology. It was first introduced in 1945 [58,59]. Preparation with an air abrasion device is achieved with a high-velocity air flow combined with microscopic aluminum oxide particles, creating an abrasive stream of particles that cuts and removes tooth structure. Although the use of microabrasion eliminates the noise, odor, vibration, and negative psychologic connotation of a traditional dental handpiece, it only cuts hard tissue and decalcified enamel [60]. Factors that influence the speed of cutting with air abrasion are the air pressure, powder flow, particle size of abrasive powder, nozzle diameter, and nozzle angle [61]. Teeth with dentinal caries still need caries removal with hand instruments or the use of rotary instruments. A major disadvantage of air abrasion technology is the debris created during the cavity preparation [62].

Case presentation

With a diagnosis of caries, treatment of the occlusal fissures on the maxillary premolars was initiated (Fig. 1). A dental dam was placed. When using an air abrasion device, the dental dam provides a better means of controlling and evacuating the fine abrasive powder that is used during cavity preparation. Because the lesions were expected to be minimal with only slight extension into the dentin, local anesthetic was not administered. If the lesions became more extensive, the patient understood that local anesthetic would be used. Using a setting of 70 psi with a powder flow of 2 g/min set on pulsed mode with a 0.014-inch diameter nozzle, the aluminum oxide air abrasion device was used to prepare the occlusal surfaces (Fig. 2). Santos-Pinto and coworkers [63] have found that different tip designs and

Fig. 1. Pit and fissure caries on the occlusal surfaces of the first and second maxillary premolars.

Fig. 2. Preparation of the occlusal lesions with air abrasion.

Fig. 3. Completed preparations.

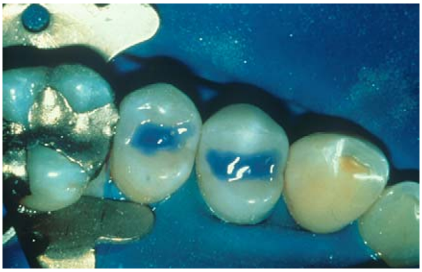

Fig. 4. Preparations etched for 15 seconds.

diameters of the air abrasion nozzle produce different cutting patterns. Smaller diameter tips produce narrower more controlled cuts. Narrow cutting follows the conceptual preparation parameters of occlusal surfaces of preventive resin preparations.

The preparations were evaluated for complete caries removal (Fig. 3). The cavity preparations were etched for 15 seconds with a 32% phosphoric acid etchant (Uni-Etch [Bisco, Schaumburg, Illinois]) (Fig. 4) and then rinsed for 10 seconds with an air-water spray and dried. A single component, fifth-generation adhesive (One Step [Bisco, Schaumburg, Illinois]) was applied to

Fig. 5. Single component, fifth-generation adhesive applied to preparations.

the preparations with a microapplicator (Fig. 5). An air stream was used to evaporate the solvent from the adhesive and to air thin the adhesive before light curing. The adhesive was light cured for 10 seconds. A flowable composite resin (AeliteFlo [Bisco, Schaumburg, Illinois]) was placed into the preparations and light cured for 10 seconds with a quartz halogen light. The restorations were finished and polished using conventional techniques. The completed restorations were well sealed (Fig. 6). The dam was removed, and the occlusion was checked and adjusted.

Site-specific burs for conservative preparation in preventive resin restorations

Recently, smaller-tipped burs have been introduced to diagnose and treat enamel lesions and to evaluate the extension of caries. Originally, smaller burs such as the no. 330, no. ½ round, no. 1 round, and no. 33½ inverted cone were recommended for preparing PRRs. Recently, a new class of burs that are thin enough to allow easy penetration into pits and fissures has been introduced (Fissurotomy burs [SS White Burs, Lakewood, New Jersey]) [1,21,64]. In some cases, the surface of the pit or fissure appears to be intact and relatively healthy, with only slight discoloration or staining of the pit and fissure. Use of these burs allows the clinician to prepare the pit or fissure

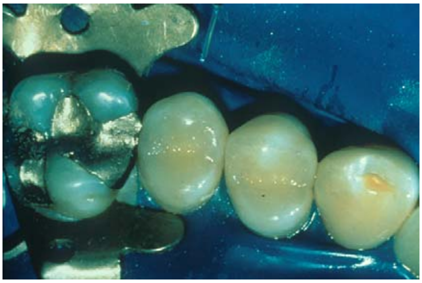

Fig. 6. Completed restorations with flowable composite resin.

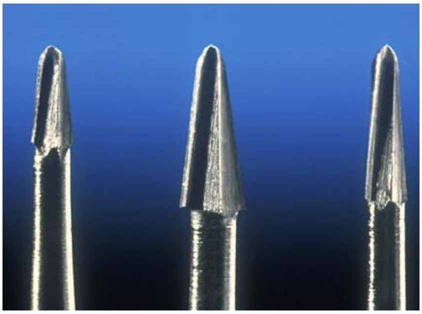

Fig. 7. Fissurotomy burs (SS White Burs, Lakewood, New Jersey).

in many cases without anesthesia owing to the small surface area of the tip. Once the preparation access has been opened and the caries explored, decisions for further extension can be made. Fissurotomy burs are available in three different configurations: the Fissurotomy original (1.1-mm wide by 2.5-mm long), the Fissurotomy Micro NTF (0.7-mm wide by 2.5-mm long), and the Fissurotomy Micro STF (0.6-mm wide by 1.5-mm long) (Fig. 7). Other manufacturers have developed thin diamonds to mimic the Fissurotomy shape (Fig. 8).

Case presentation

A patient presented for treatment with a history of not having dental treatment for 5 years. The maxillary first and second molars and second premolar were diagnosed with caries. Bite-wing radiographs did not show the extent of the caries. After anesthesia was administered, a dental dam was placed. To gain access to the distal portion of the maxillary second molar, a W8AD wingless distal extension rubber dam retainer (Hu-Friedy,

Fig. 8. Thin and narrow diamonds for minimally invasive cavity preparations (Brasseler USA, Savannah, Georgia).

Fig. 9. Carious lesions on the occlusal surfaces of the maxillary posterior teeth.

Chicago, Illinois) was placed (Fig. 9). Although the occlusal surface felt hard to an explorer, when the teeth were transilluminated, the caries appeared to be more extensive. The first and second molars were entered with a Fissurotomy original bur, and after the caries was better visualized, the teeth were prepared using a no. 245 bur (SS White, Lakewood, New Jersey). The mesio-occlusal pit of the first molar and occlusal pit of the second premolar had minimal caries. The decision was made to perform a preventive resin preparation using a NTF Micro Narrow Tapered Fissurotomy bur (Fig. 10). The NTF Fissurotomy bur allowed the fissure to be explored with minimal tooth removal to evaluate the extent of the caries and to complete the preparation. The outline of the preparations was dictated by the extension of the caries (Fig. 11).

The preparations were etched with a 35% phosphoric acid (Gluma Etch 35 Gel [Heraeus-Kulzer, Armonk, New York]) for 15 seconds (Fig. 12). The teeth were thoroughly rinsed with an air-water spray for 10 seconds and dried, leaving the teeth slightly moist. The adhesive (Gluma Comfort Bond + Desensitizer [Heraeus-Kulzer, Armonk, New York]) was applied to the tooth preparations using a BendaBrush Micro (Centrix, Shelton, Connecticut) (Fig. 13) and allowed to sit for 15 seconds. The adhesive was air dried for 5 seconds and then light cured for 20 seconds. The larger

Fig. 10. Minimally invasive cavity preparation of the occlusal surface of the maxillary first molar using an NTF Micro Narrow Tapered Fissurotomy bur.

Fig. 11. Completed cavity preparations.

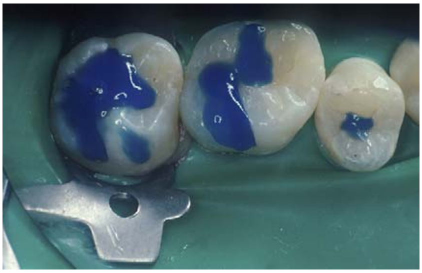

Fig. 12. Preparations etched.

Fig. 13. Application of adhesive resin.

preparations were restored by placing increments of Solitaire 2 (Heraeus-Kulzer, Armonk, New York) into the preparations with preloaded tips (Fig. 14). The high density of the composite allowed the second increment of the restoration to be shaped to final form with the condenser nib (Fig. 15). The nib of the condenser was wetted with the remaining Gluma Comfort Bond + Desensitizer to enhance the adaptation of the composite resin to the cavosurface margins and then light cured. The preventive resin preparations in the first molar and second premolar were restored with Flowline (Heraeus-Kulzer, Armonk, New York) flowable composite resin (Fig. 16).

Fig. 14. Restorative composite resin placed in conventional cavity preparation.

Fig. 15. Adaptation of composite resin to cavosurface margins with a smooth nibbed condenser head.

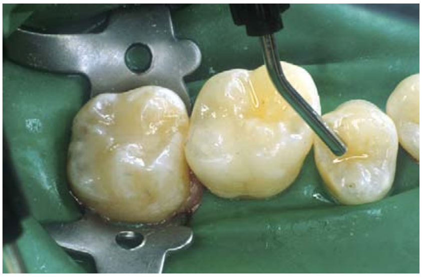

Fig. 16. Use of flowable composite resin in minimally invasive cavity preparation.

As stated previously, flowable composite resins are perfectly matched to fissurotomy preparations because they can be placed with a needle tip, and the material adapts to the small-sized preparations. The restorations were finished and polished using conventional composite resin techniques (Fig. 17). The rubber dam was removed and occlusion verified.

Controlled removal of hidden caries with a self-limiting polymer bur

A 23-year-old woman presented with numerous pit and fissure carious lesions. She had received regular dental care and was told that the dark

Fig. 17. Completed restorations.

stains on the occlusal surfaces of her molars needed to be ‘‘watched.’’ Clinical evidence of pit and fissure caries on the occlusal surfaces was seen (Fig. 18) and confirmed using a DIAGNOdent (KaVo, Lake Zurich, Illinois) laser fluorescence caries detector on the occlusal surface of the maxillary first molar. Radiographic evidence of caries was visible (Fig. 19). Local anesthesia was administered, a dental dam was placed, and access was made using a no.169L bur in a high-speed handpiece with water spray. Although the initial penetration into the enamel demonstrated minimal caries, fiberoptic transillumination of the tooth revealed shadowing below the enamel surface consistent with the radiographic appearance. The lesion was more extensive than it initially appeared to be on the occlusal pit and fissures. The lesion was opened to reveal a classic hidden caries appearance (Fig. 20).

Removal of caries can be accomplished with hand instruments or rotary instruments. Although round-ended metal carbide burs are traditionally used to remove caries, as lesions approach the pulp, there is concern that metal burs will remove sound dentin and put the pulp at risk. For this reason, hand instruments are typically used in deep preparations for caries removal. Recently, a unique polymer instrument, the SMARTBUR (SS White Burs, Lakewood, New Jersey), has been introduced [19,65]. SMARTBURs are available in the most popular round shapes for caries

Fig. 18. Occlusal caries on the maxillary first molar.

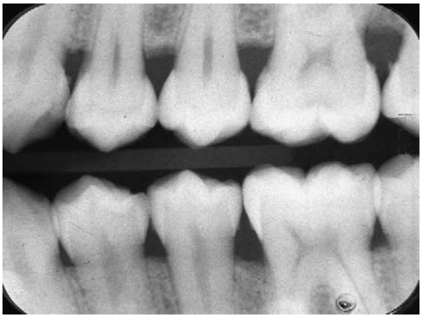

Fig. 19. Bite-wing radiograph demonstrates evidence of hidden caries on the maxillary first molar.

Fig. 20. Access to carious lesion reveals that it is more extensive than was initially evident.

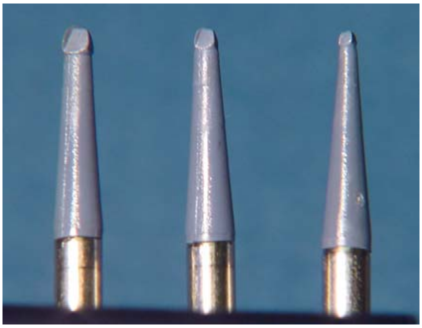

Fig. 21. SMARTBUR selection (SS White Burs, Lakewood, New Jersey).

removal, that is, RA no. 2, no. 4, and no. 6, with an innovative flute design (Fig. 21). The cutting surface of the instrument is made from a medical grade polymer that has a hardness less than that of healthy enamel and dentin but harder than that of carious dentin. This unique aspect of the instrument allows it to be used selectively to remove carious tooth structure

Fig. 22. Removing caries using a SMARTBUR.

without removing or damaging healthy tooth structure unnecessarily. It is used at slow rotation rotary speeds of 500 to 800 rpm using a light touch with a slow-speed handpiece and a latch contra-angle attachment. Open carious lesions on accessible facial and lingual surfaces can easily be treated with SMARTBUR instrument sizes appropriate for the outline form and caries removal.

The caries in the 23-year-old patient was removed using a SMARTBUR no. 6 for the initial caries removal (Fig. 22), followed by the use of a SMARTBUR no. 2 to remove the caries at the dentinoenamel junction. Although the internal dentin was discolored, it resisted penetration by a sharp explorer (Fig. 23). The tooth was restored with an adhesive amalgam restoration.

Laser tooth preparation

Lasers were first introduced to dentistry in 1989 with the limited use of desensitization. Currently, a wide variety of lasers are used for soft- and hard-tissue applications. Although traditional mechanical hand-pieces create vibration during tooth preparation, the introduction of the

Fig. 23. Complete caries removal.

Fig. 24. Use of a Waterlase YSGG laser (Biolase, San Clemente, California).

yttrium-scandium-gallium-garnet (YSGG) laser, or Waterlase (Biolase, San Clemente, California), allowed for the preparation of enamel, dentin, and carious tooth structure [66]. The YSGG laser cuts hard tissues using a pulsed high-energy photonic laser beam at 2780 nm. At this near infrared wavelength, the water particles are energized and combined with water vaporization to produce hard-tissue (enamel, dentin, and bone) and soft-tissue ablation. The Waterlase then uses water and air to remove the ablated tissues from the treated area. Unlike when using a conventional handpiece, the removal of tooth structure is achieved in a noncontact off-tooth mode [67,68]. The focused laser beam allows for precise tooth structure removal in the treatment of carious lesions of all sizes (Fig. 24) [20,45,67,68].

Summary

Using a dental mirror and explorer during a clinical examination, the clinician can make the observation that there are pits, fissures, and grooves on the surfaces of teeth. The decision-making for the diagnosis of carious pits and fissures has changed owing to better understanding of the carious process and improved diagnostic techniques [69]. Even with newer technologies for caries diagnosis, it remains difficult to chart the progression of the disease [70–73] because considerable variation is noted when this type of caries is examined microscopically [74].

The many advances in instrumentation, materials, and techniques have assisted clinicians in making the transition from traditional principles of cavity preparation and restoration to more conservative minimally invasive dentistry. These advances combined with accurate and early diagnosis of caries and caries risk assessment and management have paved the way for the conservation of tooth structure, eliminating the needless destruction of healthy enamel and dentin. This article has presented an overview of clinical techniques for the treatment of minimally invasive carious lesions and those lesions referred to as hidden caries.

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