# Operating Microscopes and Zero-Defect Dentistry

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**ABSTRACT**

Operating microscopes are celebrating their 25th anniversary in dentistry. Initially resisted by endodontists and mainstream dentists, there has been a recent surge of interest in microscope-enhanced dentistry. In endodontics, the microscope is becoming standard equipment.

This article discusses a change in the endodontic-restorative protocol and highlights a clinical case that demonstrates the tremendous advantage of advanced magnification when married with other forward-thinking techniques. It concludes with an exploration of the rationale and science of zero-defect restorative dentistry, dentinal caries removal, and finally a review of the science of microscope-enhanced dentistry.

**RÉSUMÉ**

Les microscopes opératoires célèbrent leur 25e anniversaire en médecine dentaire. Initialement boudés par les endodontistes et les dentistes, on constate maintenant un intérêt grandissant pour la médecine dentaire de pointe et l'utilisation du microscope. En endodontie, le microscope est maintenant un instrument courant.

Cet article traite d'un changement apporté dans le protocole de l'endodontie et de la médecine dentaire restauratrice et expose un cas clinique qui démontre l'avantage du grossissement combiné à d'autres techniques avant-gardistes. En conclusion, on aborde l'analyse raisonnée et la science de la médecine dentaire zéro-défaut, l'enlèvement des caries de la dentine et finalement on fait une revue de la science de la médecine dentaire de pointe et l'utilisation du microscope.

***About the Author***

*Dr. David Clark, DDS, is the founder of the Academy of Microscope Enhanced Dentistry, an international association formed to advance the science and practice of microendodontics, microperiodontics, microprosthodontics, and microdentistry. He is a course director at the Newport Coast Oral Facial Institute in Newport Beach, California. Dr. Clark served Clinical Research Associates in the "Update Series" lectures and as an interim Dentist/Researcher from 2005 to 2007.*

*Dr. Clark authored the first comprehensive guide to enamel and dentinal cracks based on 16-power magnification in the* Journal of Esthetic and Restorative Dentistry. *He has written numerous articles relating to minimally invasive dentistry, biomimetic endodontic shaping, and the role of advanced magnification in modern dental practice.*

*Dr. Clark has developed new techniques and materials, including the endo-restorative casting; a new shape for the class II composite, the "Clark Class II"; and a matrix and interproximal management system, the Bioclear Matrix System, that promises a real advancement for both bonded porcelain and direct composites. He has helped pioneer the concept of biomimetic micro-endodontics, which is a significant departure from Schilderean shaping.*

Operating microscopes are celebrating their 25th anniversary in dentistry. Initially resisted by endodontists and mainstream dentists, there has been a recent surge of interest in microscope-enhanced dentistry. In endodontics, the microscope is becoming standard equipment (Figure 1). At a recent opinion leader's forum, the question was posed: "Should microscopes be required for all endodontic treatment?" This incredible swing in endodontic opinion also is being felt in general dentistry. As dental schools begin to integrate the microscope into the curriculum, two new frontiers in dentistry will be realized: minimally traumatic dentistry and zero-defect dentistry.

This brief article discusses a change in the endodontic-restorative protocol and then highlights a clinical case that demonstrates the tremendous advantage of advanced magnification when married with other forward thinking techniques. The article concludes with an exploration of the rationale and science of zero-defect restorative dentistry, dentinal caries removal and finally a review of the science of microscope-enhanced dentistry.

## Modern Decision Making for the Compromised Tooth

Implants have raised the bar to the point where heroic attempts to restore the compromised tooth should generally be accompanied with a conversation that includes the option for implant replacement.

An argument can also be made that the predictability of implants places additional pressure on the restorative dentist; the loss of a restored tooth after a 5-year lifespan may have been acceptable in 1960, but may be unacceptable in 2008.

Microscope-enhanced dentistry is changing the endodontic-restorative protocol, altering the thought process when determining when to save or extract a tooth. Microscopes offer additional methods for caries assessment and endodontic therapy, moving the profession closer to zero-defect restorative dentistry.

The decision to "extract or save" is a constantly evolving art form. In microscope-enhanced dentistry, the thought process in the endodontic-restorative protocol is often inversed. Rather than "endodontics then restorative," it is often "restorative, then endodontics" as clinicians can assess the likely outcome and use this information in decision making. Today's finished case should be sealed exquisitely, pleasing esthetically, and accompanied by regenerated papillae. With advanced magnification, the additional visual information afforded to the clinician with the benefit of shadowless, coaxial light combined with infinity corrected optics enhances the clinician's ability to create clean, caries free margins, which, in turn, can create an optimal restorative seal. Clinicians also can assess the actual invasion of the biologic width and potential for healthy and esthetic soft-tissue contours.[1] For example, in the case presented, caries removal, margin identification, and the potential for papilla regeneration could be verified by restorative investigation. "Restorative investigation" is an important concept that is defined as "The clinical practice of prosthodontic disassembly,

Figure 1. The author at work with his microscope, a G6 Global surgical microscope.

Figure 2. Preoperative view of deep caries on mesial aspect of upper right central incisor.

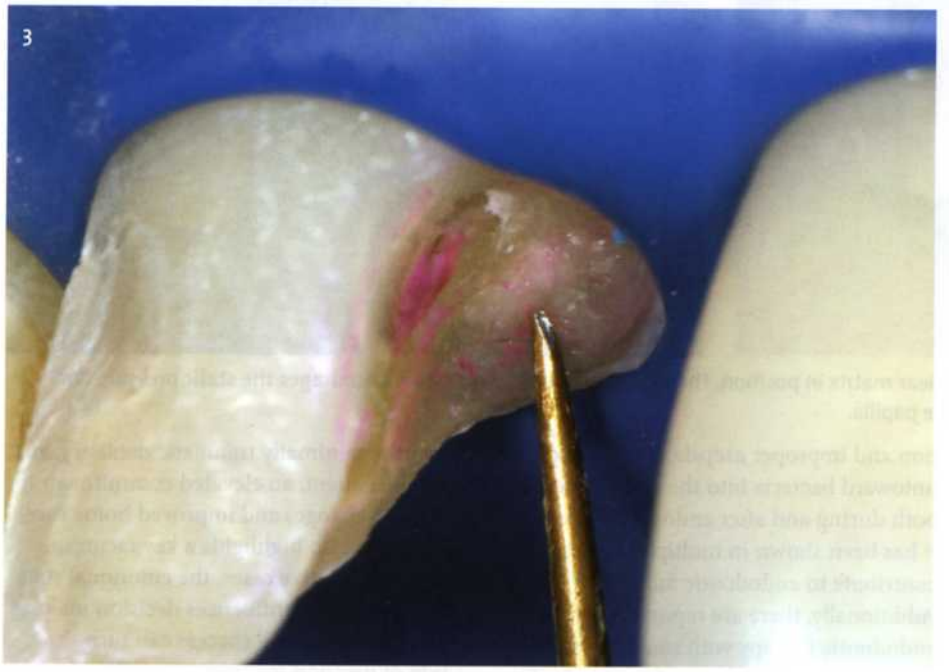

Figure 3. Initial caries removal. Application of caries-indicator solution did not stain the dentin. Extremely soft dentin often does not allow penetration of the dye, creating a false negative caries assessment (original magnification 8x).

restoration removal, caries excavation, microsurgical access, and tissue retraction; the goal of which is to assess the true extent of dental pathology combined concurrent with the long term restorative potential of the tooth."[2] After these issues are deemed satisfactory, then, and only then, is the pulp chamber re-accessed and endodontic therapy initiated. This evolution in triage has the potential to become the standard of care in the modern era of dentistry.

## Case Summary

The patient, a 56-year-old woman, was vacillating between treatment plans for her upper arch: a full immediate upper denture or restorative reconstruction. While the treatment for the lower arch was proceeding, she began to experience pain with the upper right central incisor (Figure 2). She had a class reunion that was a week away. She desperately wanted to attend this important function without pain and with a smile that did not embarrass her.

Implants were not an option for the upper arch for financial reasons. She was faced with a decision of either removing the tooth and receiving a temporary partial denture, or initiating restorative treatment combined with endodontic therapy. The patient chose the latter because it allowed for retention of the tooth as an interim treatment until a final decision was reached for the maxillary arch.

Figure 3 demonstrates the tooth after caries removal was thought to be complete. Although the dentin did not stain with caries-indicator solution, in the author's experience the use of high magnification to evaluate hardness is the ultimate test of sound dentin. Magnification (16×) revealed that gross caries was still present. Figure 4 demonstrates exploration of the deepest layer of "noodle dentin." Final evaluation of the nuances of sound dentin is demonstrated in Figure 5. A coarse diamond can be used to assess dentin because at 20–24× magnification the scratches can be used as clues to assess dentin hardness.[3] Carr has shown that the unaided eye cannot distinguish between two lines that are closer together than 200 microns. With the microscope, 20 micron assessment is possible.

To create an ideal embrasure form, a Bioclear matrix (Tacoma, WA) was used (Figure 6 and Figure 7). This anatomically shaped matrix encourages the papilla to regenerate.[4]

The composite was cured, then shaped and polished. Modern porcelain polishers, such as the D♦Fine™ (Clinician's Choice, New Milford, CT) or Jazz™ series (SS White Burs, Inc, Lakewood, NJ), yield a finish that is absolutely breathtaking (Figure 8).

After the patient and clinician were confident that the tooth was a good investment, delicate endodontic access (Figure 9) was created and endodontic therapy was completed in a more sterile environment.[5,6]

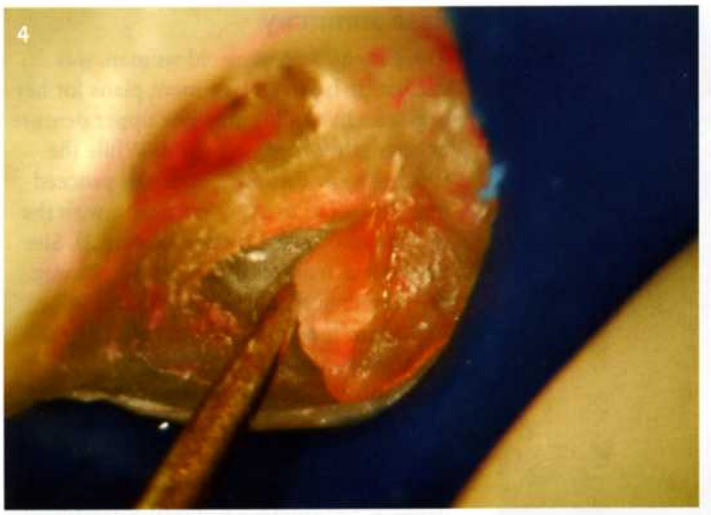

Figure 4. Soft dentin being teased with an explorer (original magnification 16x).

Figure 5. Complete caries removal confirmed by scratch marks from a coarse diamond bur. Softer, infected dentin does not exhibit this type of surface texture (original magnification 24x).

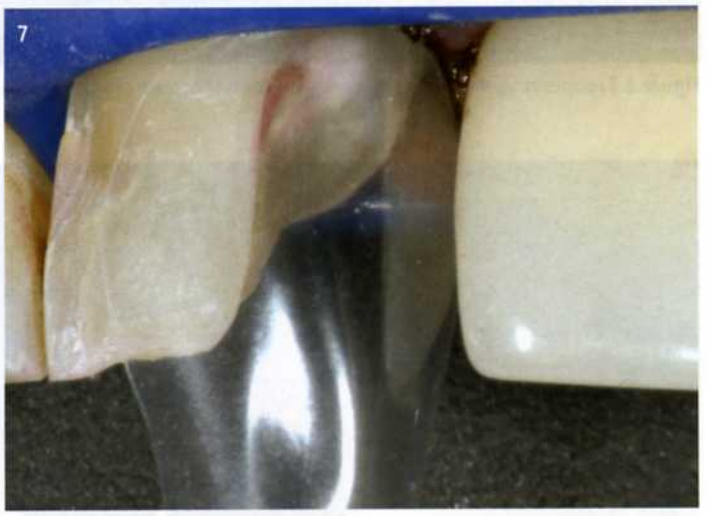

Figure 6 and Figure 7. The anatomically shaped Bioclear matrix in position. The aggressive cervical curvature encourages the static pressure and scaffold needed to stimulate the regeneration of the papilla.

In the traditional approach, endodontics is performed first with either no restorative seal in the interproximal area of caries or a marginally sealed temporary restoration. Bacterial strains such as *Enterococcus faecalis* that are commonly cultured from the root canal systems of endodontic failures are rarely cultured from the pulp spaces of cases of irreversible pulpitis (no radiographic lesion, partially or fully vital pulp) such as the featured case.[7] The logical conclusion discussed by the endodontic community is that these problematic bacteria can only gain access into the canals and periapical areas through coronal leakage *after* endodontic therapy, *in between* endodontic appointments, or *during* endodontic therapy from inadequate isolation and improper asepsis. Introduction of untoward bacteria into the canal systems both during and after endodontic therapy[8-12] has been shown in multiple studies to contribute to endodontic failure.[13-16] Additionally, there are reports of failing endodontic therapy with multiple failed endodontic re-treatments that were ineffective until a well sealed coronal restoration was placed.[17] Other cross sectional studies have shown that a good coronal seal is at least as important as a good root filling.[18]

The patient was so impressed with the result (Figure 10) that this one event created the excitement and optimism to retain rather than extract her upper natural dentition. Accompanying this decision is a victory for minimally traumatic dentistry, and for the patient, an elevated commitment to lifestyle changes and improved home care. This case also highlights a key factor in many restorative cases, the emotional state of patients that influences decision making and how one small success can turn the tide of decision making.

## Zero-Defect Restorative Dentistry

Caries removal is a fundamental task of traditional dentistry. Unfortunately, the commercially driven focus of bleaching, veneers, lasers, and implants has distracted some away from the topic of caries removal. The basic preparation tool (carbide and diamond burs) of dentistry is very similar to what it was generations ago.



Figure 8. A, Preoperative view of deep caries on mesial aspect of upper right central incisor. B, Immediate postoperative view. The long, infinity-edge margin allowed an ideal esthetic result – a heroic composite restoration that is as smooth as the contralateral tooth that has a porcelain crown. This exceeds all expectations of what we can do with composite.

Traditional burs can in no way differentiate between healthy and unhealthy tooth structures. The only known selective hardness cutting instruments are Smartburs™ (SS White Burs, Inc.), which are not readily available. The tactile differences between decayed dentin (soft) and healthy dentin (hard) is the single most common tool that is employed by practitioners in the determination on of which structures to remove.[19] Although there are many ways in which a clinician can assess carious dentin, today's most common approaches include radiographs, caries-indicator dye, spoon excavator or explorer tip (tactile hardness) tests, and laser fluorescence detection[20–22] (Table1).

**Table 1. Traditional clinical dentinal caries assessment**

| |
|---|
| • Radiographs |
| • Dentinal color |
| • Dentinal hardness (spoon excavator or explorer) |
| • Uptake of caries-indicator dye |
| • Laser Fluorescence (Diagnodent) |

The presumption that healthy dentin is "harder" is supported by extensive research.[23] The most predictable clinical indicator of sound versus unsound dentin is hardness.[24] The Knoop hardness scale of infected dentin ranges from 0 to 30, affected dentin from 30 to 70, and healthy dentin from 70 to 90. Ideally, dentin removal should be terminated once the affected dentin has been reached, in the 40 to 50 Knoop hardness range. Microscopic evaluation at extreme levels of magnification provides additional visual information to assess the texture and hardness of dentin that can augment the traditional tactile approach to dentin hardness (Table 2).

Maintaining areas of affected dentin that may be discoloured will not compromise the tooth-restoration complex.[25] However, some studies have shown a compromised long term resin bond to discoloured, affected, and amalgam contaminated dentin.[26] In these cases, the use of a glass ionomer sandwich technique is an option,

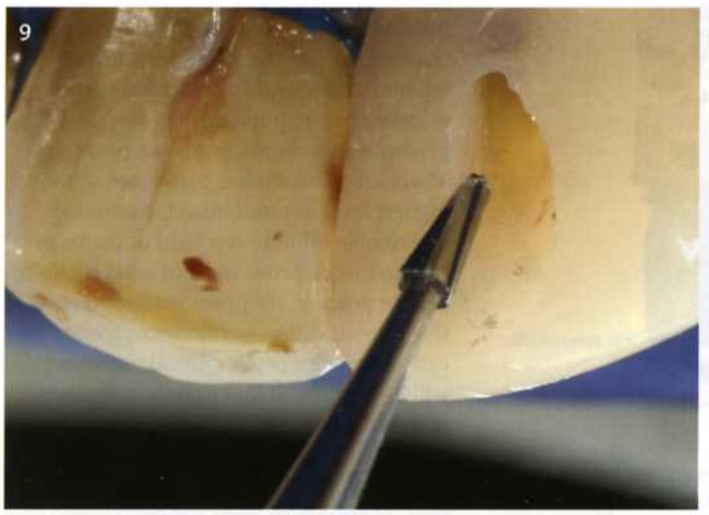


Figure 9. Endodontic access with a conical carbide is less traumatic than with fissure burs or round burs. Pictured is a prototype CK endodontic access bur from SS White Burs, Inc. (original magnification 4x).


Figure 10. At 4 weeks, there was partial papilla regeneration. The patient had very little postoperative discomfort and was ecstatic about the esthetic result.