MICRODENTISTRY: CONCEPTS, METHODS, AND CLINICAL INCORPORATION

Carlos Murgel, DDS, PhD

Microdentistry can be defined as the practice of minimally invasive dentistry with the aid of any optical device that magnifies the operative field. As a direct consequence of the better visualization obtained, treatment can be more precise and less invasive, thus preserving the oral tissues and dental structures from unnecessary substance loss during procedures such as diagnosis, caries removal, and cavity preparation. This concept can and should be applied to dentistry as a whole, not only to those specialties that “need to see more.” This misconception is one of the factors preventing dental professionals from seeing the complete picture of magnified dentistry. The advantages of microdentistry for the dental team are numerous: lower stress levels, effective control of the operatory field, less fatigue, improved ergonomics, and more efficiency. The result is satisfaction and pride for the dental team and an unprecedented level of clinical excellence in treatment. This paper provides a brief summary of the primary factors to consider when transitioning from traditional treatment to the practice of microdentistry with the operating microscope. Int J Microdent 2010;2:56–63

The search for magnification methods to improve vision using optical devices dates far into history. In Egypt 2,800 years ago, single lenses were used to improve the vision of people with visual deficiencies. In the 13th century, double convex lenses were introduced for reading. In 1674, Anton van Leeuwenhoek developed a rudimentary microscope with a compound lens to observe blood cells. Optics also played an important part in the development of astronomy, with the pioneering work of Galileo and others.1

Unfortunately, magnification came late in clinical applications for health care, and its initial use was sporadic. Shanelec2 explains that circa 1876, the German physician Dr Edwin Sämisch introduced the use of binocular loupes during surgery. In 1950, Barraquer and Perit1 introduced the operating microscope for eye surgery. A decade later in 1960, Jacobsen and Suarez1 utilized the operating microscope for vascular surgery. In neurosurgery, the operating microscope became a subject of controversy by 1966 and was viewed by many neurosurgeons with disdain.1

This paper provides a brief overview of the transition from traditional treatment to the practice of microdentistry using the operating microscope.

MAGNIFICATION IN DENTISTRY

It is well documented that visual capacity considerably diminishes over time. Burton and Bridgman3 evaluated the visual capacity of 172 dentists and found that 27% failed a 25-cm reading test and 18% failed a 35-cm reading test. The authors also showed that 96% of the dentists who failed the 25-cm test and 93.5% of those who failed the 35-cm test were 45 years old or older and that the working distance of this group was longer than the conventional one.
Dentistry has become a more visually demanding profession, especially in recent decades. Caplan⁴ argued that the use of more sophisticated and complex techniques and materials demands an increase in manual dexterity. To achieve improved dexterity, the author recommended the use of prismatic loupes because of their superior quality compared to conventional acrylic loupes.

Even today, there is some resistance to the incorporation of magnification methods in dentistry. Forgie et al⁵ evaluated 1,280 general clinicians in Scotland and found that only 9% of the participants were using some kind of magnification method routinely. In 1993, Friedman and Atchison⁶ suggested that a lack of visual acuity may lead to a significant variability in diagnosis and treatment planning.

It is important to emphasize that the use of magnification by dental students, lab technicians, hygienists, dental assistants, and general dentists and dental specialists can improve the quality of treatment.⁷ The widespread use of magnification will provide benefits for both dental health care providers and their patients.

**METHODS OF MAGNIFICATION**

There are several methods of magnification available for the dental team that can be useful in all clinical and laboratorial stages of dentistry. The equipment varies widely in technical specifications, optical quality, expandability, and price. It is up to the professional to select the method that is best suited to his or her needs and financial capacity.

Of all the magnification methods available, the two most popular are loupes and the operating microscope.⁷ Both methods are widely used. There are fundamental differences between these methods not only in their optical characteristics, but also in their clinical use and capabilities.

The posture of the operator differs according to the method chosen. Krueger et al⁸ showed that professionals who routinely used loupes had more physical complaints than those who used the operating microscope. This difference was a direct consequence of the better ergonomics obtained with the operating microscope as well as the higher-quality optics.

The final decision about which magnification method to use should be based on an analysis of needs and technical specificity rather than on marketing or initial cost. To maximize the benefit of such equipment, critical self-evaluation is needed to identify what changes must be made to incorporate magnification on a daily basis. These changes will certainly include learning new instruments and techniques to take full advantage of magnified vision.
Loupes

There are several different types of loupes available today, which can be divided into three groups based on their optical characteristics: simple, compound, and prismatic. Loupes are easy to use and generally do not require major changes in the way that one practices. Selection should be based on the short- and long-term needs anticipated by the user. It is wise to choose the highest quality of optics available to match the anticipated applications.

The greatest advantage of loupes is their easy incorporation and portability. Major disadvantages include fixed magnification, eyestrain from convergent optics, and poor ergonomics that lead to a strained posture in the cervical region. The most commonly used level of magnification in dentistry is around 2.5× and up to 5×. A key step in the correct selection of loupes is to find one’s own preferred working distance and then match it to the focal distance of the loupes (Fig 1).

Operating Microscope

The operating microscope is an excellent tool with several advantages when compared to loupes. These include different levels of magnification and excellent coaxial light transmission via fiber optics. The operating microscope provides not only excellent magnification and illumination, but also the opportunity for digital documentation, improved ergonomics, and enhanced precision. Further, the microscope makes it possible to share the magnified operating field with the dental assistant using an assistant’s binocular attachment. The biggest disadvantage of this technology is the longer learning curve and the need for a paradigm shift concerning many of the traditional concepts in dentistry.

Incorporating the operating microscope into a dental practice will require changes to many key concepts and techniques. The technical skills and treatment philosophy needed to effectively use the microscope can be a revolutionary way to achieve superior clinical results. Following the complete incorporation of this powerful technology, these new techniques become a way of life that can be far removed from the old way of practicing dentistry (Fig 2).

TRANSITION TO MICRODENTISTRY

Teamwork

Traditionally in the medical field, the surgeon is never alone when the operating microscope is being used. A well-trained team must be present to provide assistance. This allows the surgeon to remain focused on the operating field while team members pass instruments, medicaments, and other materials. By using a team approach, the surgeon can work without interruption.

In dentistry, the opposite is often true because many professionals prefer to work alone or because they work with an undertrained dental assistant. This presents difficulties when learning to use the operating microscope. The lack of training and teamwork makes it dif-
difficult to effectively incorporate the operating microscope into routine practice and leads some dentists to comment that they are slower and less productive when using the microscope.9

The “do it alone” approach is one of the major difficulties for dentists who wish to learn this technology. It is mandatory to develop a highly trained team that is able to work under constant magnification. Repeated interruptions caused by looking away from the magnified field to reach for instruments or materials, incorrect posture, patient movement, and improper microscope positioning can be true efficiency killers.

A poorly trained dental team will be an obstacle to fully realizing the potential of the operating microscope. Unfortunately, frustration and anger are often the consequence, and this usually leads to improper and inefficient use of the equipment.

With proper training, each member of the dental team has specific duties and tasks to accomplish during any given procedure. Ideally, the dentist and dental assistant are both viewing the magnified operative field through the microscope, and their equipment and materials are carefully placed for efficient use and transfer. This allows for a smooth workflow, which will improve the precision, efficiency, and productivity of any specialty.

Office Design

In the medical field, the surgical suites that house the microscope are generally quite large, and much of the other equipment in the room is also large. In dentistry, the operatories are usually smaller, and thus there is a need for smaller equipment. Many dental offices use a design concept that dates back to G.V. Black’s model, in which sets of cabinets are placed inside the operatory. Unfortunately, besides being antiquated and unproductive, such an office design can be an impediment to the incorporation of the operating microscope.11 Ideal incorporation of the microscope often requires changes in operatory design and organization (Fig 3).

Most dental operatories are based on old methods of practice, making it difficult to accommodate modern technologies such as computers, digital radiographic equipment, and the operating microscope. When such technologies are introduced to traditional operatories, they may compound an already inefficient workflow. This will often lead the clinician to blame the new technology. It can also create enormous frustration and lead to a loss of both time and money.

Gary Carr, considered by many to be the father of microdentistry, developed a system where the operating microscope is at the center of the operatory design.11 In this design, all of the ergonomic movements necessary to work with this technology are accounted for. Since 2002, the authors have collaborated with Dr Carr to develop the Total Digital Office system. This is a design concept that was created to maximize efficiency and productivity in all dental procedures by incorporating existing technologies while also planning for the future.
Simplicity and efficiency are the core features of these new design concepts. Unlike in traditional office design, in the new arrangement the dentist no longer moves around the dental chair using potentially harmful posture and positioning. Now the dental chair and patient rotate and move around the clinician while allowing visual and working access to both arches.

This operatory design was created to be as simple as possible with only the essential equipment and materials necessary to produce excellent clinical results with minimal movement and disruption of the workflow. With this design, the financial investment can be reduced by saving thousands of dollars on unnecessary cabinets and equipment (Fig 4).

The Total Digital Office system is under constant development to create an ideal operatory. The incorporation of new technologies and concepts demands new approaches to office design and a major paradigm shift (Fig 5).

Microscope Selection

Microscope selection is fundamental to success and to maximizing the benefit of this technology. It is mandatory to buy equipment developed specifically for dentistry. This is a long-term investment that should take into...
consideration applications one may wish to incorporate over an entire professional career. Unlike other electronic equipment, the optical quality of a microscope does not become outdated. With this in mind, one should buy the best equipment possible to prevent the need to buy upgraded equipment in a few years. The wrong decision today may jeopardize plans to use this equipment to its full extent in the future.

There are two critical characteristics of an operating microscope: the level of magnification and the size of the illuminated field. These characteristics will define what you can and cannot do with the microscope. Many users think that the operating microscope should magnify the operating field as much as possible and that the lower levels of magnification are not important. However, as a simple rule, the initial magnification should be as low as possible and the illuminated field should be as large as possible. The ideal equipment should have a wide range of magnification with the lower end close to what is available with a good pair of loupes (2.5×) and a large illuminated field available at all magnification levels. To illustrate these two principles, Figs 6 to 13 show the influence of these factors when viewing the same object under different simulated microscope configurations.
DISCUSSION

The concepts presented here may be met with some resistance by those who are satisfied with the status quo. The questions we need to ask ourselves are (1) can we see the full anatomical details, and (2) can we expect to provide the highest level of care to our patients without using the microscope? These questions require reflection on the part of each practitioner. Change is not easy, but the benefits for practitioners and patients are worth the effort and investment. When practicing dentistry based on “real vision” rather than on tactile sensation or clinical experience, the change is transformative. The revolution in quality and excellence is unquestionable, and clinicians will feel no desire to return to the “traditional” way of practicing.12
The pace of technological change in dentistry has been rapid over the last few decades, but the true revolution still lies ahead. This will occur when we fully understand the importance of enhanced vision and the accompanying techniques on our patient care, allowing for excellence in all clinical and laboratory stages of treatment (Figs 14 to 20).

**CONCLUSION**

Excellence is not a luxury but a goal we must all aspire to. The practitioners of such a noble profession as dentistry cannot afford to see less and do less. It is time for students in all fields of dentistry to learn from day one that they cannot adequately visualize the working field without high-quality magnification. The revolution in dentistry has finally begun.

**REFERENCES**