Microscope-Enhanced Periodontal Therapy: A Review and Report of Four Cases

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Abstract

Aim: The aim of this report is to review the status of the use of surgical microscopes and microsurgery and their clinical application in the field of periodontics.

Background: The use of magnification systems and periodontal microsurgery are part of a broad movement in dentistry toward the use of minimally invasive procedures to replace the need for more extensive surgical procedures. While magnification systems are widely used in endodontics, their application in periodontics is still in its nascent phase. However, clinicians have reported that use of magnification facilitates the use of minimal invasive periodontal surgery.

Technique: The surgical microscope is an invaluable aid for periodontists in the diagnosis and treatment of periodontal disease. Magnified vision used in conjunction with microsurgical instruments and techniques can lead to a higher quality of care and an improved surgical outcome.

Summary: Surgical operating microscopes have shown promising results in the hands of periodontists who are properly trained in their use. Despite the apparent advantages, there is still a lack of “high level of evidence” in the form of controlled clinical trials to estimate the magnitude of the real benefits of the microsurgical approach over the conventional approach.

Clinical Significance: Even though all the procedures shown in this review can be performed using normal vision, performing these procedures using a surgical microscope and microsurgical instruments offers definite advantages in terms of improved visual acuity, superior approximation of wounds, rapid wound healing, decreased post-operative morbidity, and increased acceptance by the patients.

Keywords: Microscope, ergonomics, wound healing, periodontal plastic surgery, esthetics, microsurgery, root planing.

Introduction

Contemporary periodontal therapy extends well beyond merely treating the bacterial component of periodontal disease. Increased patient awareness has generated the demand for an ideal therapy encompassing the elimination of disease and the restoration of esthetics and function that is administered with minimal trauma and discomfort. These expectations can be met by the periodontist who extends expertise beyond conventional technology and employs the use of minimally invasive procedures using various magnification systems.

At present the use of an operating microscope in periodontics is confined to plastic surgery, but it can help the clinician with diagnostic procedures and nonsurgical periodontal therapy. The aim of this report is to review magnification systems and their clinical application in the field of periodontics as well as to present four cases treated with microscope-enhanced therapy.

The Surgical Operating Microscope

A variety of magnification systems are currently available to clinicians ranging from simple and prism telescopic loupes to more complex and advanced surgical operating microscopes. Each magnification system has its own advantages and limitations. Surgical operating microscopes are widely used in the field of microvascular surgery and other medical fields, but in dentistry they have been largely limited to use in endodontics. However, the popularity of periodontal plastic surgery has enhanced the use of microsurgery in periodontics because of an increased visibility of the surgical site and the creation of smaller surgical wounds, resulting in an expedited healing process with minimal post-surgical discomfort.

The surgical microscope was introduced to dentistry by Apothekar in 1981.\textsuperscript{1} Shanelec and Tibbetts\textsuperscript{2} published a series of papers documenting the use of the surgical microscope in dentistry and termed it “Microscope Assisted Precision Dentistry” (MAP).\textsuperscript{3}

The first surgical microscopes to be used were the fixed type that were difficult to maneuver. Most modern microscopes available are the articulating type that feature an articulating arm that allows easy movement of the microscope from one position to another during a procedure without moving the entire microscopic unit. Other features available include rotating variable magnification allowing changes in magnification to match surgical needs, electronically foot-controlled focus...
and magnification for further convenience, and objective lenses with various working distances. A useful range in dentistry is 250 to 350 mm. Another useful feature available is a foot-operated shutter control for a microscope-mounted camera that allows the surgeon to compose the photographic field as the procedure unfolds without interrupting the surgical procedure. Ceiling, wall, and floor mounting options are available for surgical microscopes. The surgical microscope must have both maneuverability and stability for practical use in periodontics (Figures 1 and 2).

**Limitations**

The following is a list of limitations of a surgical operating microscope:

1. Surgical microscopes are expensive.
2. Training and practice are required to gain proficiency.
3. Microscopic units require space for maneuverability, a solid mounting for stability, and a good external source of illumination in addition to its built-in light system.

**Advantages**

A summary of the features and the advantages of a contemporary surgical operating microscope is presented in Table 1.

**Microsurgery**

Microsurgery can be defined as the refinement in surgical technique by which normal vision is enhanced through magnification.

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Table 1. Characteristics of a contemporary surgical microscope.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Function</th>
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<tr>
<td>Coated optics with achromatic lenses</td>
<td>Provides the best optical resolution and most efficient illumination.</td>
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<tr>
<td>Galilean optics with binocular eyepieces that are joined by offsetting prisms to establish parallel optical axes</td>
<td>Permits stereoscopic vision without eye convergence. Optical element is more advanced, thus enhancing depth-of-focus and field-of-view characteristics.</td>
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<tr>
<td>Rotating variable magnification</td>
<td>Allows the clinician to change working magnification easily to a value appropriate for the clinical task at hand.</td>
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<tr>
<td>Assistant eye piece attachment</td>
<td>Facilitates the surgical assistant’s visibility during microsurgery procedures.</td>
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<tr>
<td>Fiberoptic coaxial illumination</td>
<td>Focuses the light parallel to the microscope’s optical axis to eliminate shadows. This allows the surgeon to look directly into the deepest reaches of the oral cavity, such as pockets and angular bony defects.</td>
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<tr>
<td>Microvision</td>
<td>Microvision allows definitive visualization of root surface deposits and irregularities. The surgeon can view previously unseen periodontal anatomy, thus facilitating better clinical judgment. Permits easy identification of ragged wound edges during surgery for trimming and suturing.</td>
</tr>
<tr>
<td>Video and still imaging cameras and attachments</td>
<td>Ideal for documenting periodontal pathology and procedures of all types, using a digital or 35 mm image-producing beam-splitter camera attachment. High-quality video documentation is possible through a video beam-splitter attachment.</td>
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History and Introduction

The first report of microsurgery dates back to 1922 when Nyles first performed eye surgery under a microscope. By the 1960s microsurgery was standard in specialties such as neurology and ophthalmology. Microsurgery has been used in endodontics since 1986 and was introduced to the specialty of periodontics in 1992. Microsurgery embraces the following values:

• Enhancement of the surgeon’s motor skills to improve surgical ability. This is accomplished by increasing the precision of movements and decreasing involuntary tremor.
• Reduction of tissue trauma at the surgical site through the use of small instruments and a smaller surgical field.
• Application of microsurgical principles to achieve passive and primary wound closure. The aim is the elimination of gaps and dead space at the wound edge to circumvent new tissue formation needed to fill the surgical voids as well as to avoid the painful and inflammatory phase of wound healing.

In a broader sense, microsurgery implies an extension of surgical principles that encourage the paramount importance of gentle handling of the tissues and exceedingly accurate approximation of wound edges. This is not a conceptual revolution in periodontal therapy, but merely improving the accuracy and gentleness of what is already being done in everyday practice.

Besides the potential promotional or marketing advantages, periodontal microsurgery offers an improvement in predictability, cosmetic results, and patient comfort level over conventional periodontal surgical procedures. This is especially true of regenerative procedures requiring the application of materials and techniques that are difficult to use successfully and predictably within the confines of normal vision. For example, using 20x magnifications, vascular microsurgeons routinely anastomose vessels with a diameter of 1 mm or less. Using 120x magnifications, cellular biologists routinely perform subcellular operations on chromosomes. Within the limitation of their motor skills, it is possible for periodontists to learn to use magnification in the range of 10–20x to achieve surgical tolerances from 1–2 mm to as small as 10 microns.

In periodontal surgery, the benefits of surgical magnification involve the exploration of minimally invasive approaches and effective wound closure.

In a study on the outcome of periodontal surgery involving 26 patients with a deep interdental infrabony defect, Cortellini and Tonetti found improved visual acuity fostered increased soft tissue management with resultant gains in clinical attachment levels.

During the past decade, focus has been on the design and performance of surgical procedures for periodontal regeneration. Specific surgical approaches have been advocated to preserve soft tissues and to achieve stable primary wound closure in order to seal the area of regeneration from the oral environment.

Minimally Invasive Surgery Technique (MIST)

The minimally invasive surgery technique (MIST) was designed specifically to treat isolated infrabony defects using periodontal regeneration. The foundations for the MIST include:

• Application of largely tested modified papilla preservation technique (MPPT)
• Simplified papilla preservation flap (SPPF)
• Application of passive internal mattress sutures to seal the regenerating wound from the oral environment.

The primary objectives of the MIST include the following:

• Reduced surgical trauma
• Increased flap/wound stability
• Creation of a stable primary closure of the wound
using the enhanced motor skills learned and conditioned during microsurgery training sessions with a surgical microscope. Although cognitive retraining and muscle fiber reconditioning cannot be accomplished without practice using a microscope, once established the new skills become an indispensable resource available to execute the fine motor movement required in the microsurgical technique. These enhanced motor skills come into play at the outer border of distinct visual acuity and have been termed “metascopic skills”.

2,7

Microsurgical Instruments

Microsurgical instruments are specifically designed to minimize trauma. They are circular in cross-section to permit rotational movement by the clinician and are used to make a clean, nonragged incision to prepare the wound for healing by primary intention. Incisions can be established at a 90° angle to the surface using ophthalmic microsurgical scalpels. Since microsurgical instruments are made of titanium, they are strong, lightweight, and nonmagnetic. A variety of shapes and sizes of microsurgical scalpels and ophthalmic scalpels can be used for periodontal procedures (Figure 3).

Titanium microinstruments such as tissue forceps, microscissors, breakable carbon steel blade, scalpel handle, needle holder, micromirrors (furcation and interdental), microelevators, microretractors, and root resection instruments are also available.

Figure 3. Ophthalmic blade at 16x magnification.

Cortellini and Tonnetti16 found uneventful early wound healing with no edema, hematoma, or pain along with statistically significant one-year CAL gain and PD reduction. This was a case cohort study of 13 deep isolated intrabony defects in 13 patients, microsurgically accessed using the MIST and the application of EMD (enamel matrix derivative).

Cairo et al.17 described the treatment of periodontal pockets with shallow to moderate bony defects in the esthetic zone that combined preservation of the still-attached gingival fibers and maintenance of the body of the interdental papilla using microsurgical flap access. The results in terms of attachment level gain and residual pocket depth showed use of the microsurgical approach helped to minimize marginal tissue recession and improve esthetics in the treatment of these intrabony defects.

Visual acuity of the clinician is obviously important, as is the use of tactile sensitivity and proprioception in the provision of dental care.14,18 It could be argued the impact of surgical magnification may not be as significant for dental hygienists given the periodontal focus of their daily work. Once the tip of the instrument is placed subgingivally, tactile sensitivity and proprioception may be more critical to the outcome of the dental hygiene therapy than visual acuity.6,14

Proprioceptive guidance is of little value under a microscope, so visual guidance is used to make a midcourse correction of the operating hand position to maximize operator dexterity and fine movements required for the treatment procedure. This means incisions are accurately mapped, flaps are elevated with minimal tissue damage, and the wound is closed precisely without tension in the soft tissue to reduce post-operative morbidity for the patient.

In a fully developed microsurgical periodontal practice, perhaps 70–80% of typical periodontal microprocedures could be performed at a magnification of 10–20x. The remainder could be accomplished with loupes under 6–8x

• Reduced surgical chair time
• Minimization of patient discomfort and side effects.
Sutures for Microsurgery

Sizes 6-0 to 10-0 absorbable sutures are used to approximate wound edges accurately. For periodontal microsurgery, usually the 3/8” reverse-cutting needles ensure optimum results. The length of needle can vary from 5 mm to 13 mm depending on its area of application. Along with material properties, the color of the suture material is important in microsurgery since noncolored material is invisible even under magnification. Very dark-tinted suture thread is the most visible (Figure 4).

Advantages of Microsurgery

Table 2 summarizes the advantages of the use of the surgical microscope for surgical and nonsurgical periodontics.

Burkhardt R and Lang NP, in their study, showed that root surface coverage with a subepithelial connective tissue graft using a microsurgical approach substantially improved the vascularization of the grafts, seen with fluorescent

Table 2. Advantages of the use of the surgical microscope for surgical and nonsurgical periodontics.

<table>
<thead>
<tr>
<th>Advantages for the Patient</th>
<th>Advantages for the Periodontal Surgeon</th>
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<tr>
<td>• Reduced trauma and relatively painless.</td>
<td>• Permits preparation of both hard and soft tissue wound surfaces so they may be joined together according to the accepted microsurgical principle of butt-joint wound approximation to encourage primary wound healing and enhanced periodontal reconstruction.</td>
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<tr>
<td>• Improved esthetic result.</td>
<td>• Wound healing studies show epithelial anastomosis of microsurgically joined surgical wounds in animals within 48 hours. Because surgical trauma is minimized during microsurgery, less cell damage and necrosis occurs. This means less inflammation and decreased pain.</td>
</tr>
<tr>
<td>• Increased predictability of outcome.</td>
<td>• Magnification allows the surgeon to compare the conventional surgical procedure, which appears as gross crushing and tearing of delicate tissues.</td>
</tr>
<tr>
<td>• Higher acceptance by patients.</td>
<td>• The endpoint visual appearance of the typical microsurgical procedure is far superior to the endpoint appearance of conventional surgery; the magnitude is startling in photographic documented cases.</td>
</tr>
<tr>
<td>• There is a strong theoretical rationale suggesting well-approximated wounds heal faster than incompletely approximated wounds and less surgical trauma results in better outcomes of healing than more surgical trauma. Thus, smaller surgical wounds caused by microsurgery facilitate faster healing.</td>
<td>• Ergonomics: Hand position and body posture are closely related to improved motor skill made possible by a microsurgical approach to therapy. The various postural and ergonomic methods of reducing unwanted hand movement result in more precise surgeries. These methods also greatly reduce surgical fatigue as well as spinal and occupational pathology common to practicing periodontists.</td>
</tr>
<tr>
<td>• Microsurgical wound apposition minimizes gaps or voids at the wound edges, promoting rapid healing with less post-operative inflammation and pain.</td>
<td>• Motor coordination is greatly improved when surgeons use microsurgical instruments specifically designed to employ a precision grip of the hand.</td>
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angioaograms, and resulted in increased percentage of root coverage compared with applying a conventional macroscopic approach.\textsuperscript{21}

Results of a qualitative study at Vancouver Community College (VCC) in British Columbia involving dental hygiene students and clinical educators suggested physical health benefits of surgical magnification. The study participants reported decreased neck, back, and shoulder problems; decreased time leaning forward; and decreased eye fatigue and enhanced vision.\textsuperscript{13,14} Thus, in the long term, beneficial ergonomic aspects of microscopy may be the most influential factors in its adoption by the dental profession at large.

**Periodontal Applications Of The Surgical Operating Microscope**

The surgical microscope has proven to be an effective tool in endodontics and restorative dentistry. In periodontics, microsurgery can be very useful in the following:

1. Diagnostic procedures
2. Crown lengthening
3. Regenerative periodontal surgery
4. Root coverage procedures
5. Papilla reconstruction
6. Smile designing
7. Implantology

**Diagnostic Tool**

The surgical microscope may be of value in the location and visualization of a variety of substances and defects. Such is the case with deposits on the surfaces of the teeth that may escape the naked eye (Figure 5). Further debridement can be carried out under magnification to ensure complete detection and removal of the deposits.

The surgical microscope can be invaluable in facilitating a detailed inspection of tissue defects such as Stillman’s cleft (Figure 6) or an aberrant frenal pull (Figure 7).

Below are descriptions of several periodontal treatment procedures using the surgical microscope: scaling and root planing (SRP), microsurgical crown lengthening, and the performance of a connective tissue graft for root coverage.

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*Figure 5. Detection of subgingival calculus at 16x magnification.*

*Figure 6. Microscopic view of a Stillman’s cleft.*

*Figure 7. Microscopic view of an aberrant frenal pull.*
The root surface represents one opposing aspect of the periodontal wound making thorough root planing analogous to establishing a clean soft tissue incision.

Crown Lengthening Using Microsurgery

Periodontal microsurgery is the natural transition from conventional surgical principles to a surgical ethic in which the microscope is employed to permit the most accurate, atraumatic handling of tissue to enhance wound healing.

An example of a crown-lengthening procedure using the surgical microscope is shown in Figures 12 through 15. In this case, a patient was referred to the periodontist for surgical lengthening of the crown of a maxillary left premolar using an apically positioned flap in preparation for a subsequent restorative procedure. Sulcular and vertical incisions were made using an ophthalmic blade and a full-thickness flap was raised. The margin of the flap was placed at the crest of the surface. The root surface represents one opposing aspect of the periodontal wound making thorough root planing analogous to establishing a clean soft tissue incision.

Scaling and Root Planing (SRP) Using Microvision

The importance of root debridement is recognized universally as an essential and inevitable component of periodontal therapy. Complete removal of subgingival calculus and root planing assists and enhances new attachment of the periodontal ligament. A patient with generalized chronic periodontitis had SRP performed as the initial phase of therapy using unassisted vision (Figures 8 and 9).

Following the SRP of one root surface, (tooth 13), using a #3-4 Gracey curette, the debrided root surface was examined under surgical microscope. Substantial deposits remained and upon further root planing at 16x magnification using the microscope, a smooth, clean root surface was attained (Figures 10 and 11).

It is clear magnification greatly improves the surgeon’s ability to create a clean, smooth root surface. The root surface represents one opposing aspect of the periodontal wound making thorough root planing analogous to establishing a clean soft tissue incision.
alveolar bone and the vertical incisions were approximated using 6-0 absorbable sutures.

There was less tissue trauma at the surgical site, finer incisions without any ragged edges, and better tissue approximation using the fine 6-0 sutures when surgery was performed under microscope with microsurgical instruments. 7,8,18,20

Connective Tissue Graft for Root Coverage Using Microsurgery

An example of using the surgical microscope (10x magnification) for a connective tissue graft procedure to cover the exposed root (Miller’s Class I recession) of a maxillary left canine is shown in Figures 16 through 25. In this case,
Complete intraoperative coverage was achieved with minimal trauma at both the recipient and donor sites and an exceptionally pleasing esthetic outcome. Healing of the graft and the donor sites observed at intervals of one week, two weeks, one month, three months, and six months was significantly faster than if a conventional pouch was created and a single vertical incision was made at the recipient site using an ophthalmic blade. Next, a subepithelial connective tissue graft was harvested from the hard palate using an ophthalmic blade and the trap-door technique. The wound was sutured in place using 6-0 absorbable sutures.
microsurgery compared to conventional surgery is because of the remarkable advantages magnification offers to microsurgery.

There are some limitations in the use of microsurgery in periodontics. The clinician operating the microscope needs to be trained. Presently, there are very few institutions offering such training for surgeons in the use of a microscope, which could lead to its indiscriminate use. It is prudent to remember that nonsurgical as well as conservative surgical therapy still forms the basis of a quality periodontal practice.

The very nature of periodontal surgery demands a surgical microscope capable of offering a broader area of focus compared to needs in endodontics. A periodontal surgeon needs to change the focus of the microscope continuously while performing microsurgery, which can be a cumbersome process with the current generation of microscopes. However, advancing technology surgical approach had been used (Figures 26 and 27).

### Discussion

Development in human research and technology has enabled the dental profession to offer better therapy to patients. Periodontics is a rapidly evolving field of dentistry with major changes occurring during the last five decades. The transition from use of a radical gingivectomy for the elimination of periodontal pockets to the use of flap surgeries and different regenerative measures is indicative of such change. The introduction of microsurgery is a part of this process and has helped the periodontist in treating the patient in a conservative manner using enhanced visibility of the surgical field and minimizing surgical wounds to achieve a favorable treatment outcome. Thus, the superior endpoint of esthetic appearance following
will likely overcome the disadvantages seen with the present generation of microscopes. This will no doubt benefit the clinicians in their endeavor to provide excellent treatment options for their patients.

Summary

Surgical operating microscopes have shown promising results in periodontal therapy. Despite the advantages stated previously, as well as those cited by various other authors, there is still a lack of “high level of evidence” in the form of controlled clinical trials to estimate the magnitude of the real benefits of the microsurgical approach over the conventional approach.

Clinical Significance

Even though all the procedures shown in this review can be performed using normal vision, performing these procedures using a surgical microscope and microsurgical instruments offers definite advantages in terms of improved visual acuity, superior approximation of wounds, rapid wound healing, decreased post-operative morbidity, and increased acceptance by the patients.

References

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