REVIEW

MICROSURGERY IN PERIODONTICS : A BRIEF REVIEW

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ABSTRACT

Periodontal microsurgery is one of the promising advancements, in the field of surgical periodontal therapy. In the field of dentistry, Apotheker and Jako first introduced the microscope in 1978. Shanelec and Tibbetts can be considered as pioneers in periodontal microsurgery. Periodontal plastic microsurgery incorporates the use of a surgical microscope in an attempt to increase visibility, thereby minimizing soft tissue trauma and enhancing the surgical results. Periodontal microsurgery has added a new dimension to different techniques such as guided tissue regeneration, root coverage, gingival augmentation, hard tissue augmentation, osseous resection, cosmetic crown lengthening etc. The introduction of loupes and surgical operating microscopes along with the micro-instruments have driven the periodontal surgery to a new level of sophistication and have made the microsurgical approach a reality.

KEY WORDS

Periodontal microsurgery, surgical operating microscope, loupes, magnification, microsurgical

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INTRODUCTION

Contemporary periodontal therapy is not restricted in merely treating the bacterial component of periodontal disease. With increase in patient awareness, there is an increased demand for a therapy, that would not only focus on the elimination of disease but would also restore the aesthetics and function. During any surgical procedure, minimal trauma and discomfort are of prime importance. Considering all these aspects, periodontal microsurgery is one of the many advances that have taken place in the field of surgical periodontal therapy, that has added a new dimension to different techniques such as guided tissue regeneration, root coverage, gingival augmentation, hard tissue augmentation, osseous resection, cosmetic crown lengthening etc.

Microsurgery has been broadly defined by **Daniel RK (1979)** as surgery performed under the magnification provided by operating microscope. Microsurgery is described by **Serafin**[1] **(1980)**, as a methodology, a modification, and refinement of existing surgical techniques that uses magnification to improve visualisation and has implications for and applicability to all specialities.

Since its inception, microscope-assisted medicine has grown in all spheres. Microsurgery in general, was never considered as an independent discipline, but a technique with an application in different surgical disciplines. Periodontal surgery is one of them. It is based on the fact that the human hands, by appropriate training, are capable of performing finer movements which are beyond the control of the naked eyes[2].

In the field of periodontics, the introduction of loupes and surgical operating microscopes along with the micro-instruments have driven the periodontal surgery to a new level of sophistication and have made the microsurgical approach a reality. Periodontal plastic microsurgery incorporates the use of a surgical microscope in an attempt to increase visibility, thereby minimizing soft tissue trauma and enhancing the surgical results. Studies have demonstrated improved vascularisation, enhanced mobility of flaps, and hence, possibility of obtaining primary wound closure, less post-operative discomfort and thereby providing better esthetic results[3].

The concept of microsurgery has also gained increasing significance in periodontal surgery in recent years. However, because microsurgery is generally associated with greater time and higher costs, the use of microsurgical techniques is justified only if they are clearly superior to the conventional surgical alternatives, such as regenerative surgery and plastic-esthetic periodontal surgery[4,5,6].

Evolution of Microsurgery:

History of magnification dates back to 2,800 years, when simple glass meniscus lenses were used in Egypt. In the era of modern science, in 1694, Amsterdam merchant Anton van Leeuwenhook constructed the first compound lens microscope. Saemisch, a German ophthalmologist, introduced the use of simple binocular loupes in eye surgery in 1876. In the year 1921, in Sweden, Carl Nylen, the father of microsurgery, first used a binocular microscope for ear surgery to correct otosclerotic deafness. During the 1950s, Barraquer started using the microscope for corneal surgery. During this time only, the first surgical microscope, OPMI, with a coaxial lighting system and option for stereoscopic view, was invented and commercialized by the Carl Zeiss Company[7]. In the year 1960, Jacobsen and Suarez obtained 100% patency in suturing 1-mm-diameter blood vessels for anastomosis. During the last four decades, there have been rapid innovations in the use of magnification for different procedures related to, arthroscopic, laparoscopic, neurologic, and vascular surgery.

In the field of dentistry, Apotheker and Jako first introduced the microscope in 1978. During 1992, an article by Carr, outlined the use of the surgical microscope during endodontic procedures. During 1993, Shanelec and Tibbetts conducted a continuing dental education program on periodontal microsurgery at the annual meeting of the American Academy of Periodontology.

Clinical Philosophy of Microsurgery:

Microsurgery is a surgical philosophy that improves the motor skills to enhance surgical ability. This enables decisive hand movements accomplished with increased precision and reduced tremors. Consistent application of the philosophy and techniques, which have been learned during basic conventional periodontal surgery education, is necessary for the operator to attain a satisfactory degree of experience and competence in periodontal microsurgical procedures. Training with the microscope, results in enhancement of the motor skills, which can translate to improved surgical skills. The methods of precise, delicate tissue handling, wound closure, and suturing - require concentration, micro surgical skills, which can be attained by rigorous practice. The development of new thought patterns regarding surgical esthetics is necessary, and attention must be paid to microanatomy, tissue manipulation, and surgical craftsmanship[8].

Ergonomics:

Various postural and ergonomic ways of reducing unwanted hand movements with the use of surgical microscope result in more precise surgeries and greatly reduce surgical fatigue and development of spinal and occupational pathology.

Hand Control and Physiologic tremor:

For fine finger movements, which is mandatory under microscopic magnification, some important aspects of hand function must be considered. Finger movements controlled by the long flexor and extensor muscles are relatively crude. However, when the wrist is stabilized by resting on a flat surface, angled in a dorsiflexion position at approximately 20 degrees, more accurate, finely controlled finger movement can be accomplished because of the reduction in muscle tremor provided by this "platform[9]". In microsurgery, the hand should either directly or indirectly rest on an immovable surface to avoid unwanted movements. All the movements should be with the fingertips only and should be made with a unity of effort toward purposeful, deliberate motions. There are several factors that can influence a surgeon's physiologic tremor, including anxiety, recent exercise, alcohol, smoking, caffeine, heavy meals, hypoglycemia, and medication usage[6,9]. All these factors should be kept in mind prior to the surgical appointment in microsurgical approach.

Special training for Microsurgical Surgery:

Magnification significantly reduces the visibility of the surgical field, making it much harder to control hand movements and work sequences. Clinicians must therefore adapt their old hand motor skills and master new. As the power of magnification increases, a person's awareness of the physiologic tremor of the hands also increases. To ensure that this awareness does not impair performance during surgery, the clinician should learn appropriate behavioural and mental preparatory techniques before performing microsurgical interventions.

Optical Magnification Systems

Magnification is absolutely essential for improved visualization of the surgical field and more precise manipulation of fine tissues during microsurgery. Any optical magnification system used in microsurgery must meet the following requirements:

1. It must produce an enlarged, upright and non-reversed image of the surgical field.

2. It must generate stereoscopic (three-dimensional) images that allow for exact depth localization.

3. Optical distortion must remain below the perception threshold to prevent eye strain.

4. The working distance between the system and the surgical field must be large enough to allow the surgeon to work comfortably and ergonomically.

5. The system must be equipped with a light source that optimally illuminates the surgical field.

Types of magnification

The two types of optical magnification available to dentists are:

a) Magnification loupes

b) Surgical operating microscope (SOM)

Magnification loupes

Surgical loupes for magnification enable the clinician to experience the ergonomic benefits of an increased working distance from viewing object as well as improved visual acuity. The pattern of convergent lens system is called a Keplerian optical system. The surgical loupes provide a wide range of magnification×1.5 to ×10. This degree of magnification, although lower than the operating surgical microscope, provides an effective combination of magnification, field of view, and depth of focus. The major disadvantage of loupes is that the clinician's eyes must converge to view on the operate field, which can result in eye strain, fatigue, and even vision changes when poorly designed loupes are used. But loupes are less expensive and initially easier to use[10].

Three types of Keplerian loupes commonly used in periodontics are:

i) Simple loupes

ii) Compound loupes

iii) Prism loupes

Simple loupes

Simple loupes are primitive magnifiers with limited capabilities, consisting of a pair of single, positive, side-by-side meniscus lenses. The disadvantage of simple loupe is that they are highly subjected to spherical and chromatic aberration, which distorts the image of the object that is being viewed. In spite of its cost advantages, the size and weight limitations make simple loupes impractical for magnification beyond 1.5 diameters.

Advantage

- Low cost.
- Loupes also tend to be less cumbersome in the operating field.

Compound loupes:

The compound loupes are commonly mounted in or on the eyeglasses and can be adjusted to clinical needs without excessive increase in size or weight. Compound lenses can be achromatic (limits the effects of chromatic and spherical aberration and brings two wavelengths into focusin the same plane), which is an important feature for any magnifying loupe used in periodontics.

Advantages:

- Better magnification
- Wider depths of field
- Longer working distances
- Larger fields of view

Disadvantages:

- There is lack of variable magnification.
- Individual light source may be required.
- Protective coating of anti-reflective material to prevent loss of light transmitted.

Prism loupes:

These loupes produce superior magnification since they contain Schmidt or roof-top prisms. Other technical advantages include: Better magnification, larger surgical view with wider depths of field, and longer working distances. Furthermore, because of the shorter barrels of the prism loupes, these loupes can be easily mounted on either eyeglass frames or head bands. The incorporation of coaxial fiber optic lights in prism telescopic loupes has improved the operative site illumination to a greater extent.

Surgical operating microscope:

Surgical microscope utilizes the 'Galilean optical principles.' The microscope mountings are available for ceiling, wall mount, or on the floor. Clinicians are not affected by the weight of the instrument or the challenges of maintaining a stabilized field of vision since they are external to the body. Surgical microscope has both maneuverability and stability. The fiber optic technology has improved the methods of focusing light on specific areas.

Photographic and videography aided documentation of periodontal pathology and periodontal procedures are also possible.

The main components of the optical system of an operating microscope are:

- The magnification changer
- Objective lens
- Binocular tube

- Eyepieces (ocular lenses)
- Light source.

Magnification changer:

The magnification changer consists of two Galilean telescopes with different magnification factors inserted in a cylinder. To change the magnification factor, the relative position of the two telescopes is changed in either direction by rotating the cylinder. With rotation of the cylinder, the combined action of the magnification changer, objective lens, and eyepieces, magnification ranges of x 6 to x 40 can be achieved.

Objective lens:

The objective lens forms an image of the object processed by the magnification changer while projecting illumination from the light source onto the field of view. Objective lenses with a focal length of 200 to 300 mm are available for use in periodontal surgery. The focal width generally corresponds to the working distance, that is, the distance from the lens to the surgical field.

Binocular tube:

The conventional binocular tube contains two inverting prisms that rectify the inverted image produced by the objective lens and collected by the lenses in the end region of the tube.

Eyepieces:

The role of the eyepieces, or ocular lens is to magnify the intermediate image generated in the binocular tube. Eyepieces with magnification factors of 10x to 20x are available for operating microscopes. The type of eyepiece used determines not only the magnification factor but also the size of the field of view. The higher the magnification factor, the smaller the field of view. In periodontal surgery, a 10x eyepiece generally provides a good compromise between magnification factor and size of the field of view. Modern eyepieces allow for the correction of emmetropic and ametropic eyes, which enable surgeons with refractive errors to work without glasses. They can compensate for refractive errors in the range of -8 to +8 diopters but not for astigmatism. Therefore, surgeons with astigmatism must wear glasses when using an operating microscope. Operating microscopes can achieve x3 to x40 total magnification, but magnification ranging from x4 to x24 is usually sufficient and most commonly used in periodontal surgery.

Light source:

Optimal lighting is needed to achieve maximum visual acuity. Xenon bulbs, which are used with cold light mirrors designed to protect the surgical field from heat generated by the light. The objective lens projects the light in a coaxial path via two inverting prisms to the surgical field, that is, in the direction of view.

Advantages of operating microscope

- Greater operator eye comfort because of the parallel viewing optics of the Galilean system as well as the range of variable magnification.
- Excellent coaxial fiberoptic illumination
- Accessories such as still and video cameras for case documentation.

Limitations of operating microscope

- Restricted area of vision and loss of depth.
- Loss of visual reference points.
- A steep learning curves.
- Expensive to buy.

Benefits of Microscopes in Periodontics[4]

Operating microscopes offer three distinct advantages to the clinician: Illumination, Magnification and Increased Precision in the delivery of surgical skills. These advantages are collectively referred as the microsurgical triad. The surgical operating microscope, like all magnification systems, enhances visual acuity.

This leads to:

- Increased precision of surgical skills, which results in more accurate incisions via micro surgical instrumentation, less trauma, and quicker post operative healing.
- Gentle handling of soft tissues and hard tissues.
- Extreme and accurate wound closure.
- Little damage to the surgical sites and adjacent tissues.
- Ergonomic advantage.
- Eliminates patient pain and morbidity to a great degree.
- It is perceived more favorably by the public than conventional surgery

Periodontal Microsurgical Instruments

Very precise and controlled guidance of the surgical instruments are essential in periodontal surgery, particularly when microsurgical procedures are performed. Hence the surgical instruments should have rounded non-slip handles to allow secure rotation with the fingers. In addition, the instruments must be at least 18 cm long to be held securely in the thumb, index finger, and middle finger in a pen grip. The handles should also be well balanced. Slight top-heaviness facilitates precision work.

Micro instrument set for periodontal microsurgery:

The instruments used in periodontal microsurgery are basically the same as those used in conventional periodontal surgery. Although they are finer and smaller. They must be precise enough to effectively handle the gingival tissues. Stainless steel is the material of choice for microsurgical instruments because it provides a greater degree of hardness and flexibility. In addition, the clinician should choose only needle holders and forceps with smooth jaws. Blood easily adheres to diamond-coated inserts or ridges, which can make it more difficult to grasp very fine sutures securely and can increase the risk of damaging or breaking the delicate suture threads used in microsurgery. Smooth carbide inserts have proved to be an excellent choice. The weight of each instrument should not exceed 15 to 20 gm (0.15–0.20 N) in order to avoid hand and arm muscle fatigue. An important characteristic of microsurgical instruments is their ability to create clean incisions to prepare the wound for healing by primary intention[11].

Microsurgical scalpel handle: A microsurgical scalpel handle must have rounded handles to allow the surgeon to work safely and with adequate precision. The micro scalpel blade is inserted in the fitting at the top of the handle. It is very difficult to make a precise incision with conventional scalpel blades; hence the microsurgical scalpel blades have rounded ends and these blades cut in all directions. They are also suitable for incisions in interdental spaces.

Microsurgical combination forceps:

Dissecting forceps are the most commonly used instruments in microsurgery. They come in different shapes and sizes. Straight dissecting forceps with fine working tips fulfil the requirements of plastic esthetic surgeries. The jaws of the forceps should have smooth tips to allow the surgeon to tie knots with very thin sutures without damaging the thread when grasping it with the forceps. Dissecting forceps arc held in the non-dominant hand when the clinician is tying knots. The working tips of the forceps must be 1 to 2 mm apart when held loosely in the hand. It should not be necessary to apply great force to close the forceps. The jaws of the forceps must be perfectly aligned when closed.

Papilla elevator:

The papilla elevator is a micro periosteal elevator used to raise flaps. It has semi-sharp, disk-shaped working ends of different sizes designed for atraumatic dissection of fine tissue structures, especially in the interdental area.

Microsurgical needle holder:

As needles of various sizes are used in periodontal microsurgery, the microsurgical needle holder should be designed to grasp very fine to superfine needles. It must also be slender enough to access interdental areas. The microsurgical needle holder should have smooth jaws to allow simple and controlled knot tying without damaging the suture thread. In periodontal microsurgery, locking needle holders are very useful. The needle can be securely grasped and advanced in controlled rotating movements through the tough gingival tissue without the surgeon's having to exert too much pressure on the handles of the needle holder.

Microsurgical scissors:

Curved microsurgical scissors with sharp working tips have proved ideal for periodontal microsurgical application. They are mainly used to cut sutures and are sometimes used for controlled cutting of soft tissue. Microsurgical scissors also have rounded handle designed to facilitate rotational movement.

Suture Materials:

The commonly used suture sizes for periodontal microsurgery usually are - 5-0, 6-0, and 7-0.

Applications in periodontal flap surgery:

By using microsurgical techniques, periodontal flap margins can be elevated with uniform thickness, with a scalloped butt-joint. During suturing, this facilitates precise adaptation of the flap to the teeth or with the tissues, thus eliminating the dead spaces, thereby enhancing periodontal regeneration. Studies have shown improved initial healing in the sites with microsurgical approach due to more accurate and atraumatic handling of the soft tissues. The coronal displacement of the flaps over the defects is easier with the microsurgical technique.

Study conducted by Wachtel et al. (2003)[12] with enamel matrix proteins have shown that enamel matrix derivative exerts better biologic activity in microsurgically treated sites. These can be attributed to reduced tissue trauma and less vessel injury, resulting in improve vascularization and primary wound closure.

Improved root visualization and treatment:

The importance of root debridement is recognized universally as an essential component of periodontal therapy. One of the critical determinants of the success of periodontal therapy is the thoroughness of debridement of the root surface. Success of periodontal therapy depends on visual access to the root surface for removing the residual calculus, treating the pathologically altered root surface, and achieving a clean and smooth root surface. Different studies with stereomicroscopy have demonstrated that the root planning is more effective when done under greater magnification and it enhances periodontal regeneration.

Application in gingival recession coverage:

In mucogingival surgeries, the inadvertent damage to the tissues during the surgical procedure can be greatly reduced by atraumatic surgical approach and excellent visualization of the operative field. Periodontal microsurgery enhances the normal vision by magnification and providing with sufficient lighting, leading to improvement in predictability, cosmetic result, and patient comfort levels over conventional periodontal surgical procedures.

Three-dimensional on-screen microsurgery system:

Current advances in video technology permit visualization of the surgical field on a video monitor without physical viewing through the microscope. The assembly of the three-dimensional on-screen microsurgery system comprises of two video cameras mounted on custom-fit eyepiece adapters, a dual camera-controller, an image processor, a VCR for optional recording, digital monitor to enable viewing, synchronizing signal emitter, and 120 MHz stereo eyewear. The development of this stereoscopic three-dimensional display technology proficient of providing a clear and accurate sense of depth perception is a boon for the rapidly evolving field of minimally invasive surgery.

CONCLUSION

Periodontal microsurgery is definitely a must for periodontal esthetic surgical procedure and it holds promising outcome for different other periodontal surgical procedures. The improved visual acuity due to the magnification, opens a whole new world for those who make effort and take time to become proficient in microsurgical principles and procedures. Although presently it is associated with higher cost as compared to the conventional one and requires special training for the operator, it can be anticipated that in near future it will be considered as routine procedures in periodontal therapy.

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