

# DECODING MICROSURGERY IN PERIODONTICS

## Abstract

The use of microscope has never been more welcoming than at this era. Although it has been in use since almost more than two decades in the field of periodontology yet the it has not yet been common. Microsurgery does fall under minimally invasive periodontal surgery however, the concept in itself is tedious to understand. The microsurgery is triad of magnification, illumination and instruments. The working of microscope is necessary knowledge for one to practice this. The hand to eye co-ordination and use of the instruments which far smaller than the conventional can result in an ideal condition for minimal tissue trauma and maximal patient comfort. The present review has attempted to explain the gist of microsurgical principles in periodontics.

**Keywords:** Dental loupes, Microsurgery, Microscope, minimally invasive

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## I. INTRODUCTION

The use of microscopes in dentistry allows the practitioner to see things that are difficult to be perceived by the naked eye. It illuminates the operating field with a homogenous light without shadows and provides rich contrast and an excellent three-dimensional effect. By definition, microsurgery is refining the surgical technique by increased visual acuity using a microscope which is 10X or more magnification.<sup>[1]</sup> The microsurgery in any field focuses on three basic principles. Enhancement of motor skills is the first requirement. Reduction in tissue trauma which is achieved by small instruments and a reduced surgical field is the second while obtaining a passive and primary wound closure is the third principle.<sup>[2]</sup> The entire discipline of microsurgery is based on the fact that with adequate training, human hands are capable of performing the movements unable to detect by naked eye; thus, it is not an individual technique but refinement of already existing surgeries.<sup>[3]</sup> Hence, the microsurgical techniques can enhance the outcome of an already prevailing surgical technique in hands of an trained expert.

One of the important factors in microsurgery is improved visual acuity, the training is rigorous but the benefits overcome that. The improvement in field and magnitude of vision can be very advantageous in terms of surgical result. loupes are available easily is one of the answers to that but however, those routinely available do not increase the vision to level required for microsurgical procedures. They can be ergonomic and economic method to achieve a better hand eye co-ordination which is required for true microsurgery.<sup>[4]</sup> The horizon of microsurgery broadens as one improves and employs the basic optical magnification and ergonomic techniques and technology.

Microsurgery has already been popular in medicine before it was introduced in dentistry. In the field of periodontology, it was started in the year 1992 and has been widely used since. Over the last few years, new age periodontal surgery incorporates a lot of clinical procedures such as Guided tissue regeneration, cosmetic crown lengthening, gingival augmentation procedures, soft and hard tissue ridge augmentation, osseous resection, and dental implants that demand not only the high-end clinical expertise but also visualisation to obtain apt and improved execution of the same technique to achieve better wound closure and hence better results. This seconds the use of microsurgery as to increase the field of vision beyond the scope of naked eye or the one magnified by loupes.<sup>[5]</sup> Periodontal microsurgery requires traditional techniques and philosophies so as to allow the clinician to attain results that once thought, owing to their individual technique sensitivities, to be unlikely on a consistent basis.<sup>[6]</sup>

Over 2,800 years, a simple glass meniscus lens was described in ancient Egyptian writings. It was the first reference to magnification. The first compound-lens microscope was constructed by Anton van Leeuwenhook in 1664. In 1921, Carl Nylen, who is considered the father of microsurgery, had used binocular microscope for the first time in Sweden to correct otosclerotic deafness.<sup>[7]</sup> Carl Zeiss was the first company to invent and commercialize first surgical microscope<sup>[8]</sup>, OPMI 1, with a coaxial lighting system and the option for stereoscopic view. The use of microscope in dentistry was introduced by Apotheker in 1978. The first branch of dentistry to embrace magnification was endodontics in the year 1986, later in 1992 it was introduced in periodontics. After that significant work was presented and done in the field of microsurgery such as Shanelec & Tibbetts (1998) presented a continuing-

education course on periodontal microsurgery at the annual meeting of the American Academy of Periodontology in 1993.<sup>[9]</sup>

## II. TERMINOLOGY

- 1. Magnification:** Magnification refers to viewing of an image or a model in an enlarged form or manner.<sup>[10]</sup> Surgical operating microscope offers a number of different magnification options within the same instrument which is not possible with use of loupes. Microscope s in dentistry has six steps of magnification (2.5x, 4.0x, 6.7x, 10x, 16x and 24x). For initial conservative and restorative procedures, medium powers (4.0x and 6.7x) are beneficial. It can also be used for general surgery and periodontics.
- 2. Working Distance:** It refers to the distance between the surface/area being treated and the plane of the eye. The working distance is calculated by the linear measurement of the objective front lens to the surgical site. It is directly proportional to the distance of the operating area, i.e. shorter the focal length of lens, the closer the lens to the operating field and vice versa. Thus, it is the most important factor to affects posture and comfort of the operator. If the lens is placed too close it may result in too proximity of the patient resulting in an awkward position. Also, it may limit the range of motion of the working hands.<sup>[11]</sup>
- 3. Depth of Field:** It is the range in which the clinician is able to maintain visual accuracy at an appropriate working distance. This gives a clear image of all the object within this field and the objects outside of this field are blurry. It is effective for the clinician to keep the maximum amount of the image in sharp focus.<sup>[7]</sup> It is expressed in terms of a range or difference of upper and lower limit, in which the image of the object remains focused and visible.
- 4. Width of Field:** It is the view which the operator sees or visualise in terms of height and width while using the magnification device. Also known as the field of view<sup>[12]</sup>, it is inversely proportional to magnification i.e., higher the magnification, the smaller is the width of field.
- 5. Declination Angle:** It is the angle/degree at which the eyes are declined/positioned to view the surgical area under treatment. It ranges from 15-44 degrees.<sup>[12,13]</sup>

## III. MICROSURGICAL TRIAD

There are three elements of microsurgery

- Magnification
- Illumination
- Instruments

These 3 elements are collectively called the microsurgical triad<sup>[14]</sup>, the improvement of which is a prerequisite for improved accuracy in surgical interventions.

**1. Magnification:** Magnification is the property of eye and retinal cells which produce an image using the electrophysiologic process. Visual acuity is influenced by these factors. Another consideration in visual acuity is the presence and conditions of lighting. The relation between visual acuity and light density is well established: a low light density decreases visual acuity. A light density of  $1000 \text{ cd/m}^2$  results in best eyesight. At densities higher and lower than this, visual acuity decreases. This clearly emphasizes the need of optimal lighting conditions in the operatory. Another way to increase and enhance the visual acuity and vision respectively is by magnifying the object in question. Image size can be increased in two ways:

- By getting closer to the objects and
- By magnification.

Differentiation between two objects and their images is done by the ability of the lens of the eye to accommodate the objects in the front. The lens can change its form by increasing the ability of the lens of the eye to accommodate, allowing it to focus on nearer objects.

The normal vision without any aid will give a highest possible visual resolution of 0.2mm. The hand to eye movement co-ordination at this magnification is within 1mm. If we add up the effect of physiologic tremor in that, this will increase up to 2mm. At magnification of 20x, hand movement can be accurate up to  $10\mu$  and visual resolution approaches  $1\mu$ .<sup>[15]</sup> A magnification of 10x to 20x is appropriate for Periodontal microsurgery. In dentistry two basic types of magnification systems are commonly used are loupes and surgical microscope.

The magnifying lenses (loupes) were first for dental procedures but later they were replaced by surgical microscopes. Loupes, though can be used for magnification, but have certain disadvantage to their credit. Magnification and focal length (working distance) are fixed for loupes. There is no foot control to adjust focus thus the clinician will have to adjust it with hands every time it is required. The surgical microscopes have foot controls therefore it is easy to adjust the focus during procedures. The focal length and magnification are also adjustable with microscopes. Surgical procedures are usually done at 5x to 40x magnification while a magnification range of 7.8x to 12.5x is used for anastomosis of vessels.<sup>[16]</sup>

**2. Illumination:** At times use of an additional source of lighting is necessary for optimal vision. Certain factors are considered during selecting an accessory lighting source which includes quality and the brightness of the light, directing the light within the field of view of the magnifiers, ease of focusing, total weight and ease of transport between surgeries.<sup>[16]</sup> However, with every additional lens placed, there will a loss of 4% of transmitted light due to reflection which increases up to 50% in telescopic loupes, leading to reduction in brightness. The use of fiber optic illumination can be beneficial in such cases. It can be attached to hand piece, instruments or loupes. The use of halogen lamps has gained popularity lately for illumination.<sup>[14]</sup>

- 3. Instruments:** The microsurgical instruments are smaller than the routine instruments to as much as by tenfold. This results in smaller surgical field with less injury & bleeding. They are required to have an ergonomic design for precise operation as they are used for prolonged periods. They have circular cross section for easy conduct of rotational movements by the operator. They are held with pencil-hold type of grip in contrast to palm-hold grip seen in general surgical instruments. They are made up of titanium or surgical stainless steel. Titanium instruments are lighter intrinsically strong and nonmagnetic; however, they are more prone to deformation and are expensive. The weight is more towards their top end for precise handling during use. The length is around 8 cm and it lies on the saddle the operator's thumb and index finger. There is color coding of the instruments to avoid metallic glare off the instruments while working. The force should be adequate for the use of every instrument, like the force for lock on needle holder should not exceed a locking force of 50g as high locking forces generate tremor and low locking forces reduce feeling for movement.<sup>[17]</sup> The various instruments used are: Knives, Retractors, Microscissors, Microneedle holders, Microforceps, Tying forceps, Microscalpel, suture materials and needles.

#### IV. DEVICES USED IN MICROSURGERY

- 1. Loupes:** Loupes are composed of two monocular microscopes which are positioned as two side-by-side lenses angled in such a way that it can be focussed and give the image as one. The image formed is due to convergent lens system and has stereoscopic properties<sup>[18]</sup> Dental loupes can magnify only to a limited extent which is usually 1.5X to 6X. The magnification of up till 3X provided by loupes are usually insufficient for the visual acuity required for clinical periodontics. The surgical loupes can provide adequate magnification; however, the range should be optimum. The magnification of 4X can be impractical as they have smaller field of view, shallow depth of focus and excessive weight. To compensate these heavy loupes can be tried but due to weight it can be difficult to maintain a stable field.<sup>[19]</sup> In such cases prism telescope loupes with the magnification of 4X can be used for periodontal procedures as they provide an adequate combination of magnification, field of view and depth of focus.<sup>[20]</sup>
- 2. Surgical Microscope:** Surgical microscopes which are used for dental procedures are based on Galilean optics. The design includes binocular eyepieces combined with offsetting prisms to establish parallel optical axes. This gives stereoscopic vision without any eye convergence or strain. The alignment results such that eyes are focused on infinity leading to a relaxed vision without any fatigue. The achromatic lens used in operating microscopes gives best optical resolution and illumination.<sup>[21]</sup>

The adequate range of working length in dentistry is 250 to 350mm. There is an additional 100 to 150mm to working distance in case of indirect vision with the help of mirror, thus ease of changing working distance should be available. This is easily offered in surgical microscope in contrast to loupes which cannot offer such advantages. For periodontal surgery, adequate working length is a must as the assistant will have to retract the tissues and irrigate or evacuate the surgical site. Thus, the working length should be suitable for both clinician as well as assistant for adequate microsurgical visibility. Assistant eyepiece attachments are available for surgical microscopes and can greatly aid the progress of microsurgical procedures. Surgical microscopes have objective lenses

with various working distances. The surgical microscope consists of a magnification changer, objective lenses, lighting unit, binocular tubes and eyepieces. It has to be fixed to the floor or mounted to the wall/ceiling.

3. **Magnification Changer:** It is also known as Galilean changer. It has one cylinder in which two Galilean telescope systems (consisting of both convex and concave lenses) with assorted magnification factors are built. These telescopic lenses can be used in any direction depending on the position of the magnification changer. It is available in a total of four magnification systems. Straight transfer without any optics yields the factor 1. The combination of magnification changer with varied optic lenses and eyepieces yields an increasing magnification line when the control is adjusted.<sup>[22]</sup>
4. **Objective Lenses:** As processed by the magnification changer, the image is only projected by one single objective. This simultaneously projects light from its source twice for deflection by the prisms into the operating area (co-axial prisms). The most frequently used objective is 200mm (f=200mm). The focal length of the objective generally corresponds to the working distance of the object.<sup>[23]</sup>
5. **Lighting unit:** The lighting unit is essential for operating microscope of high magnification. The halogen lamps have been popular in recent years. Halogen lamps provide a whiter light as compared to conventional lamps due to their higher color temperatures. The halogen lamps give out radiation in infrared spectrum which produce heat hence it is equipped with cold-light mirrors to keep this radiation from the operating area.<sup>[20]</sup>
6. **Binocular Tubes:** The microscope have two different binocular tubes which can be straight and inclined tubes depending on the area and use of the microscope. The straight tubes the view and image are parallel to the microscope axis. The inclined tubes are inclined at 45° angulations to the microscope axis. Only inclinable tubes are used in dentistry which allows continuously adjustable viewing and are ergonomically feasible. The precise adjustment of the pupil distance (distance between the user's pupils) is the basic precondition for the stereoscopic view of the operating area.<sup>[22]</sup>
7. **Eyepieces:** When an image is generated in the binocular tube, it is magnified by eyepiece. Different magnifications can be viewed (10X, 12.5X, 16X, 20X) using various eyepieces. The selection of eyepiece is determined by the size of the field view and magnification. Since the magnification and field of view are inversely proportional, a view of 10X eyepiece can provide a better co-ordination of both the parameters used. A correction facility within -8 to +8 dioptries is seen with newer eyepieces which is purely spherical correction.<sup>[22]</sup>

The majority of microscopes available now a day's comprised of modules which can be modified and attached with equipments such as integrated video systems, photographic adapters for cameras, color printers, and powerful lighting sources.<sup>[22]</sup>

8. **Advantages of Surgical Microscope:** Significant lesser tissue trauma, patient compliance as the area of surgery is reduced, better wound healing and closure, diagnosis of the disease is enhanced along with surgical skills, predictable surgical outcomes,

improved regenerative and cosmetics outcome, documentation of the procedure can be easily done.

- 9. Disadvantages of Surgical Microscope:** Patient awareness is lacking at present, technique sensitive and requires specialization from the clinician regarding handling and optics, expensive.

## V. PERIODONTAL MICROSURGERY

The periodontal microsurgery is very different in many manners with conventional periodontal surgery. The microsurgical techniques reduce patient morbidity with lesser trauma to the tissues. The incisions are just long enough to allow access and expose the concerned tissue. The result is more aesthetically pleasing and satisfying and superior to that of conventional method. Hence it is gaining acceptance and popularity amongst the periodontists. The application is not just restricted to flap surgery but more advanced soft and hard tissue surgeries.

## VI. PROCEDURES

- 1. Root Biomodification:** Root biomodification is a critical factor in success of periodontal therapy. Lindhe and coworkers (1984) have suggested that a thoroughly debrided root surface is more crucial for reattachment of periodontal fibres. They have also shown that the procedure is more thorough under illumination. This is an ideal condition under surgical operating microscope which is an excellent source of light. Thus, it can be concluded that the procedure can be more effectively carried out under microscope.<sup>[7]</sup>
- 2. Periodontal flap surgery:** Flap reflection is done to gain access to underlying tissue which needs visualization thus incision should be extended so to there is no tension during flap closure at the same time length of incision should be adequate.<sup>[6]</sup> The length of incision could be considerably reduced by use of the surgical microscope. Historically, too small an incision for adequate access and treatment was one of the most common errors committed in flap design.<sup>[24]</sup> The thickness of flap margins and closure can be controlled maintaining uniform thickness periodontal flap that has a scalloped butt-joint margin by using microscopic visualisation. With appropriate technique, results obtained will be superior with microscope for periodontal flap surgery
- 3. Mucogingival surgery:** Periodontal mucogingival or plastic surgery are particularly technique and operator sensitive. The results largely depends upon not only on the type procedure employed but also whether or not all the indications and contraindications are met.<sup>[25]</sup> The proper adaptation, thickness and anastomosis of the flap can be maintained when surgical microscope has been used.
- 4. Restoring the Edentulous Ridge:** The edentulous requires vertical as well as horizontal increase at times. This could be achieved by the help of bone grafting, guided tissue regeneration membrane along with use of various soft tissue grafts. The use of microscope can not only enhance the technique but also give out better result.<sup>[26]</sup>
- 5. Microsurgery in implant:** Although the implant surgeries and placement are happening with or without microscope yet the use of one can only better the results. The implant placement may require increasing the width and height of ridge which can be easier with

optimal visualization of the surrounding structures. The immediate implants require careful extraction preserving as much as bony walls as possible insinuating theoretical rationale to suggest that less surgical trauma results in less pain and faster healing, and that microsurgery leads to those ends.<sup>[25]</sup>

## VII. CONCLUSION

Microsurgery is an acquired skill which requires patience and practice to get accustomed to its use and advantages in clinical periodontics. To learn the basics is of utmost importance as to utilize the surgical microscope to its full potential it is necessary to understand its dynamics and working. The clinicians are now talking about “magnification escalation” in field of dentistry is ever-growing now. The visualization of tissues and structures which were obscure till now will open many new opportunities and possibilities due to budding new techniques and instruments. It has also opened new gates for research. The microsurgical periodontology and use of microscope is still in developing stage where techniques are evolving. The clinicians are embracing the change and adapting the enhanced visualization not as last resort but as first choice to provide more than optimal patient care.

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