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Role Of Periodontal Microsurgery- "Treating Periodontitis Through The lens"

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ABSTRACT

Periodontal microsurgery is an advancement in periodontology that refines periodontal procedures and provides more precise visualization, the magnified field of view, improved accessibility and ease of performing surgical procedures with minimal complexity at a microscopic level. This review article highlights the tools, techniques and various applications of periodontal microsurgery

Key words: Microscope, Periodontics, Regeneration, Surgery.

1. INTRODUCTION

Daniel in 1979 defined microsurgery in broad terms as surgery performed under magnification by the microscope. In 1980, microsurgery was described by Serafin as a modification and refinement of existing surgical techniques using magnification to improve visualization, with applications to all specialties.[1] Periodontal microsurgery is also the refinement of basic surgical techniques made possible by the improvement in visual acuity gained with the use of the surgical microscope.[2]

2. HISTORY AND EVOLUTION

It was Anton Von Leuwenhoek, in the year 1964, who first described compound lens microscope. Later in 1912, Carl Nylen, the father of microsurgery used a binocular microscope for ear surgery. In the year1950, Barraquer et al. used this binocular microscope for corneal surgery. In late 1960, Jacobson and Suarez et al., obtained 100% patency in suturing 1mm diameter blood vessel for anastomosis through which surgical microscope gained wide acceptance in medicine.[1]

Following this in the year1978, Apotheker and Jako et al., introduced microscope to dentistry. Carr et al., in the year 1992 used a microscope for endodontic procedures. It was Shanelee and Tibbetts et al., in the year 1993 who presented a continuing education course on Periodontal Microsurgery at the Annual Meeting of the American Academy of Periodontology.[2]

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3. PRINCIPLES OF MICROSURGERY

The principles of microsurgery include: passive wound closure with exact primary apposition of the wound edge, improvement of motor skills - enhancing surgical ability and reducing tissue trauma.[2]

4. THE MICROSURGICAL TRIAD

The microsurgical triad includes illumination which is achieved through fiberoptic technology has improved the methods of focusing light on specific areas and is a standard feature of surgical operating microscopes. The second one being refined surgical skills which occur as a synergistic result of illumination and magnification. The third one being Magnification that can be achieved through the use of the loupes and the operating microscope.[2]

Various magnification tools include loupes which are further divided into simple, compound and prism loupes.

I. LOUPES

Dental loupes are the most common system of optical magnification used in periodontics. Loupes are fundamentally dual monocular telescopes with side-by-side lenses convergent to focus on the operative field. The magnified image formed has stereoscopic properties under their convergence. A convergent lens optical system is called a *Keplerian optical system.* Three types of Keplerian loupes are typically used in periodontics: simple or single-element loupes, compound loupes, and prism telescopic loupes. [3]

The simple loupes are primitive magnifiers with limited capabilities, consisting of a pair of single, positive, side-by-side meniscus lenses. Each lens is limited to only two refracting surfaces. Their magnification can increase only by increasing lens diameter and thickness. The compound loupes use multi-element lenses with intervening air spaces to gain additional refracting surfaces. Compound lenses can be achromatic (limits the effects of chromatic and spherical aberration and brings two wavelengths into focus in the same plane), which is an important feature for any magnifying loupe used in periodontics. Achromatic lenses consist of two glass lenses joined together with clear resin. The specific density of each lens counteracts the chromatic aberration of its paired lens to produce a color-correct image. The Prism loupes are the most advanced loupe optical magnification currently available is the prism telescopic loupe. These loupes employ Schmidt or rooftop prisms to lengthen the light path through a series of switchback mirrors between the lenses. This arrangement folds the light so that the barrel of the loupes can be shortened. Prism loupes produce better magnification, wider depths of field, longer working distances, and larger fields of view than other types of loupes. [3]

5. MAGNIFICATION RANGE OF SURGICAL LOUPES

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Loupes with magnifications range from 1.5 to 6x. For most periodontal procedures, loupes of 4x to 5x provide increased visual acuity with an effective combination of magnification, field size, and depth of field. Loupes of 4.5 x magnification or greater need to be thoroughly evaluated, as their depth of focus and narrow field size can make them awkward to use. The major disadvantage of loupes is that the clinician's eyes must converge to view on the operating field, which can result in eye strain, fatigue, and even vision changes when poorly designed loupes are used. [4]

Surgical microscopes designed for dentistry employ Galilean optics, which have binocular eyepieces joined by offset prisms to establish a parallel optical axis and permit stereoscopic vision without eye convergence or eyestrain. An additional binocular eyepiece can aid the microsurgical assistant. Surgical microscopes have coated achromatic lenses, high optical resolution, and a rotating magnification element that allows the micro surgeon to easily change magnification to a value appropriate for the surgical task at hand. [4]

6. PARTS OF AN OPERATING MICROSCOPE

The parts of an operating microscope include the optical unit that consists of eyepieces, binocular tubes, magnification changer, objective lens and lighting unit. The eyepieces are available in powers of 6.3X, 10X, 12.5X, l6x and 20X. For periodontal purposes generally 5X to 12 X. Eyepiece dioptre settings range from -5 to +5 and are used to adjust for accommodation & refractive error. The eyepieces magnify the interim image generated in the binocular tubes. The binocular tubes are useful in holding the eyepieces. The inter-pupillary distance is set by adjusting the distance between the two binocular tubes. The longer the focal length of binoculars, the greater is the magnification and narrower the field of view. These tubes are of three types which include straight tube binoculars which are tubes parallel to the head of the microscope, inclined binoculars that are tubes are offset at 45 degrees and Inclinable tubes are adjustable between the straight tube and the inclined tube positions and sometimes beyond 90 degrees. The magnification changer in combination with varying objective lenses and eyepiece yields an increasing magnification line when the control is adjusted. [4]

The objective lens uses focal length to determine the operating distance between the lens and the surgical field. These lenses are available with focal lengths ranging from 100 to 400 mm. A 175-mm lens focuses at about 7 inches, a 200-mm lens focuses at about 8 inches and A 400 mm lens focuses at about 16 inches. A typical microscope package could be one with 12.5X eyepieces, 125-mm is straight or inclinable tube binoculars, a power zoom magnification changer, and an objective lens of 200 mm. This will allow a clinician to operate comfortably about 8 inches from the patient and in the magnification range of about 3 X to 26 X. [4]

The lighting unit requires optimal illumination. The light source is a 10-watt xenon halogen bulb providing a whiter light than conventional bulbs. As halogen lamps emit a considerable portion of their radiation within the infrared part of the spectrum, microscopes are equipped with cold

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light mirrors to keep this radiation from the operation area. An alternative to the halogen light is the xenon lamp - functions up to ten times longer than the halogen lamp. The light has daylight characteristics with even a whiter color and delivers a brighter, more authentic image with more contrast illumination. [4]

7. ILLUMINATION

Light intensity is controlled by a rheostat and cooled by a fan. Light is then reflected through a condensing lens to a series of prisms and through the objective lens to the surgical field. After the light reaches the surgical field, it is reflected through the objective lens, magnification changer lenses, binoculars and exits to the eyes as two separate beams of light. The separation of the light beams is what produces the stereoscopic effect that allows the clinician to see the depth of field. A surgical microscope uses coaxial fiber-optic illumination producing an adjustable, bright, uniformly illuminated, shadow-free, circular spot of light that is parallel to the optical viewing axis. [5]

8. DOCUMENTATION

Documentation is important for patient and professional education and dental-legal reasons. The surgical operating microscope is an ideal platform for documenting periodontal pathology and clinical procedures. Digital images can be captured using a beam splitter and camera attachment. A foot-controlled switch permits a surgeon to record the procedure without interrupting surgery. These images represent the surgical field exactly as the surgeon sees it, as opposed to a camera view over the surgeon's shoulder. Videotape is an extremely sensitive format and does not need supplemental light. Video printers can be connected to a videocassette recorder or the video camera on the microscope. A microcomputer inside the video printer automatically analyzes the image, and prints are created in 70 seconds by a high-density sublimation dye. High-definition video cameras capture still and video images simultaneously to permit documentation of periodontal procedures for educational purposes.[6]

9. VIDEOSCOPE

The videoscope has been developed to overcome some of the difficulties which have been faced by current visualization procedures. It employs a semiflexible glass fiber optic bundle that carries an image from the surgical site to the external camera which projects the image on the external monitor. As it is semiflexible it cannot be sterilized and hence it is placed inside the disposable sheath or sheath which can be sterilized and this sheath has a sapphire lens of 2.7 mm diameter which is optimal to place inside the sulcus. It has gas shield technology which is employed to eliminate the fogging or fouling of the optics of videoscope, this technology allows the use of videoscope without the need to clear blood or surgical debris.[7]

10. MICROSURGICAL INSTRUMENTS

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For high-precision movement, microsurgical instruments must be approximately 15 cm in length. Instruments should be circular in cross-section to allow for a smooth rotation movement. The working tips of microsurgical instruments are much smaller than those of regular instruments. To provide consistent manipulation of tissues, needles, and sutures, most microsurgical instruments are manufactured under magnification to high tolerances. Needle holders and tissue forceps are made of titanium. They are resistant to distortion from repeated use and sterilization, are non-magnetized, and are lighter than surgical stainless steel instruments. Shorter instruments, as well as instruments with a rectangular cross-sectional design, do not allow as precise manipulation and therefore are not ideal for microsurgery.[8]

10.1. Microneedle holder

The needle holder is used to grasp the needle, pull it through the tissues, and tie knots. The appropriate needle-holder length depends on the nature of the operation. The most commonly used is 14 cm and 18 cm. The tips can be straight or gently curved, but the latter is most often used. The choice of the tip is determined by the nature of the suture. Usually, a delicate tip (0.3 mm) is used for 8-0 and 10-0 sutures. The needle holder with a 1-mm tip is used for 5-0 and 6-0 sutures. A needle holder should ensure that a needle is held steadily without slipping. It should be light and require minimal force from the hand. It should be a length to suit the size of the hand and be manipulated easily. A titanium needle holder is the best choice. [8]

10.2. Microforceps

Microforceps can make those manoeuvres that cannot be performed by hand. The most commonly used microforceps are 15 cm long, with round handles and 0.2- to 0.3-mm tips. [8]

10.3. Microscissors

These are used for the dissection of tissues, blood vessels, and nerves. Different sizes of scissors are used.14 cm and 18 cm long. To manage the delicate part of the adventitial tissues, 9-cm microscissors are preferable. The tips of the scissor blades can be straight or gently curved. Straight scissors cut sutures and trim the adventitia of vessels or nerve endings. Curved scissors dissect vessels and nerves. [9]

10.4. Surgical knives

Ophthalmic knives offer the dual advantages of extreme sharpness and minimal size. Several types of ophthalmic knives, such as the crescent, lamellar, blade breaker, sclera, and spoon knife are used. Compared with the standard 15 blades commonly used in periodontics, the smaller size of the ophthalmic knives facilitates surgical work. [9]

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10.5. Microsurgery sutures and needles

Microsurgery has increased the options for appropriately sized needles and sutures. Needles vary in size, shape and curvature, but most needles used in dentistry are of 3/8 curvature.[9] Periodontists frequently use a reverse cutting needle of a significant size (16 to 19mm). These characteristics allow extremely accurate apposition, closure, and immobilization of the connective tissue graft. [9]

11. ERGONOMICS IN MICROSURGERY

The physiologic tremor is the uncontrolled movement arising from both the intended and unintended actions of our bodies. Awareness of its effect is magnified by visual enhancement. During microsurgery, physiologic tremor manifests as a naturally occurring unwanted hand and finger movement. To minimize tremors, a microsurgeon must have a relaxed state of mind, good body comfort and posture, a well-supported hand, and a stable instrument-holding position. The correct operator position for nearly all procedures directly behind the patient at the 11 or 12 O’clock position. The operator should adjust the seating position so that the hips are 90 degrees to the floor, the knees are 90 degrees to the hips and the forearms are 90 degrees to the upper arms. The operator's forearms should lie comfortably on the armrest of the operator’s chair and his or her feet should be placed flat on the floor. The back should be in a neutral position, erect, perpendicular to the floor, being supported by the lumbar support of the chair, with the eyepiece inclined so that the head and neck can be held at an angle that can be comfortably be sustained. This position is maintained regardless of the arch or quadrant being worked on. It is the patient who is moved to accommodate this position. After the patient has been positioned correctly, the armrests of the doctor’s and assistant’s chairs are adjusted so that the hands can be comfortably placed at the level of the patient’s mouth.[10]

12. PATIENT, MICROSCOPE AND OPERATOR’S POSITION

The patient is placed in the Trendelenberg position and the chair is raised until the patient is in focus. Positioning of the microscope: The microscope should be maneuvered so that the circle of light shines on the working area. The operator moves the body of the microscope approximately to the working distance and then, looking through the eyepiece, moves the microscope up and down until the working area comes into focus. The inclinable eyepiece is now adjusted so that the operator’s head and spine can maintain a comfortable position with the working area in focus.[11]

The operator moves the body of the microscope approximately to the working distance and then, looking through the eyepiece, moves the microscope up and down until the working area comes into focus. The inclinable eyepiece is now adjusted so that the operator’s head and spine can maintain a comfortable position with the working area in focus.

Handgrip

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The most commonly used precision grip in microsurgery is the pen grip which gives greater stability than any other hand grip. The thumb and index and middle fingers are used as a tripod. The forearm should be slightly supine, positioning the knuckles away from you, so that the ulnar border of your hand, wrist, and elbow are all well supported. When an instrument is held with the internal precision grip, the instrument can be opened and closed with very fine control. Any tremor resulting from the thumb or index finger is minimized by contact with the supported, steady middle finger.[12]

Applications of Microsurgery in Periodontics

I. Aesthetic periodontal microsurgery

Aesthetic periodontal microsurgery to reconstruct gingival tissue over denuded roots is routine and predictable using subepithelial connective tissue grafting. The colour match, aesthetic appearance, and lack of scarring of these grafts are ideal. Microsurgical closure of the palatal donor site allows healing by primary intention without a painful period of open granulation. This greatly reduces postoperative pain. [13]

Thus to achieve optimal wound healing precise tailoring of the tissue, delicate tissue manipulation and passive primary closure of the wound are necessary. The precise tailoring is an important feature of microsurgery is the ability to create clean incisions. The design of incisions has a significant impact on how the wound edges fit together. A fundamental principle of microsurgery is making incisions perpendicular to the tissue surface, creating butt joint edges that easily approximate for wound edge stability and maintain blood supply patency. The second being delicate tissue manipulation, where the microsurgical philosophy is based on minimal invasiveness and minimal trauma. This premise extends to the manipulation of gingival tissues during surgery. Gentle handling is necessary to reduce cellular injury and subsequent necrosis and inflammation. It is also necessary to maintain tissue hydration and colour to maximize healing. [13]

After precision tailoring and gentle tissue manipulation, the final and critical element of microsurgery is achieving passive primary wound closure. A specific geometry of suturing is required, with the following six well-defined components which include

a) Angle of entry and angle of exit: The needle should penetrate the tissue at a 90-degree angle, perpendicular to the tissue surface. Passing the needle at an oblique angle cause tearing when the knot is tied
b) Bite size: Proper bite size is between 1 and 1.5 times the tissue thickness. Too small a bite size can tear the wound edges.Too large a bite size can cause under riding or overriding of wound edges. Both outcomes result in impair healing and unsightly scarring.

c) Direction of passage: After the needle has penetrated one edge of the wound, it must exit the opposing side of the wound with a direction of passage perpendicular to the incision line. This directs the suture force vectors at 90 degrees an prevents lateral dislocation at the wound edge.
d) Tension: Suturing should be accomplished with minimal tension. Gentle passage of the suture in a perpendicular direction of passage sets the stage for a microsurgical knot that does not cause tissue strangulation through ligation.Good suturing, however, can never save poor tailoring
e) Symmetry: The distance between the bite sizes on either side of the wound edge should be symmetric, as should the distance between sutures.
f) Frequency: Smaller suture material and smaller bite size makes it necessary to place more microsutures at frequent intervals along the wound edge. This supports wound closure and avoids stress breakage of sutures or tissue tearing.[14]

1) In root visualization and preparation:

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. Clinical and research studies with stereomicroscopy have demonstrated that the root planning is more effective when done under greater magnification and enhances periodontal regeneration. [15]

II. Microsurgery in Root surface debridement

It has been reported that root instrumentation is effective when done under illumination along with an improved early healing index and less postoperative pain·Furthermore, root preparation can be done with micro ultrasonic instruments. The smaller size (about 0.2–0.6 mm in diameter) of these instruments allows subgingival treatment in deep pockets with less chances of over-instrumentation of the root surface.These instruments have active working sides on all surfaces; deliver ultrasonically activated lavage in the working area and can be used with minimal water spray.In conclusion, magnification improves the root surface debridement by enhancing clinician's ability to differentiate the calculus from tooth surface and biofilm to the microscopic level, which reveals morphological contours of both supragingival and subgingival tooth surfaces and accurately procreates working end angles during instrumentation. [15]

III. Microsurgery in Interdental papilla reconstruction

Microsurgical techniques have been developed to replace the lost interdental papilla which can create phonetic problems, saliva bubbles, and cosmetic deficiencies. Success in the treatment of black triangle with periodontal microsurgery is a significant leap in the field of perio-esthetics, making it a realistic possibility. [15]

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IV. Microsurgery in Gingival recession coverage

In mucogingival surgeries, the damage to the tissues during surgery can be greatly reduced by atraumatic surgical approach and excellent visualization of the operative field. Therefore 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. [15]

V. Microsurgery in Crown lengthening

Although the comparative studies of crown lengthening and ridge augmentation with microsurgical methods are limited, magnification is beneficial in such procedures. [15]

VI. Microsurgery in Periodontal regeneration

The advantages of microsurgical approach in regenerative therapy relate to improved illumination and magnification of the surgical field that permits proper access to and debridement of the intrabony defect with an increased accuracy and minimal trauma. Furthermore, the competency to achieve and maintain a primary wound closure minimizes bacterial contamination, and thereby provides more favourable conditions for periodontal regeneration. Minimal marginal tissue recession and thus improved esthetics and a very limited intra- and postoperative morbidity, thereby high patient acceptance and satisfaction, are the other advantages of microsurgical approach for the treatment of intrabony defects. Probing depth reduction and clinical attachment level gain for the regenerative procedures performed with microsurgical approach has been found similar to those achieved with conventional surgical approach. [15]

A recent meta-analysis (Liu S et al in 2016) found no significant differences in treatment of intrabony defects treated with minimally invasive periodontal surgery (MIPS) plus biomaterials and MIPS alone for the observed parameters (probing depth, clinical attachment level, marginal recession, and radiographic bone fill), pointing out that costs and benefits should be considered substantially while deciding a regenerative therapeutic modality.[16] Isolated interproximal defects that are usually limited to interproximal site are considered ideal for bone grafting with MIPS. Generalized horizontal bone loss and multiple interconnected intrabony defects are a contraindication for MIPS and are best managed with more conventional surgical approaches. [15] In MIPS, head-mounted operating microscope (Varioscope®) with appropriate lightening is preferable rather than a surgical microscope as it allows the visualization of the defect more easily from different angles for proper debridement of the periodontal defect and the root surfaces. Apart from MIPS, minimally invasive nonsurgical therapy has shown significant clinical (probing depth, clinical attachment level) and radiographic improvements for the treatment of periodontal intrabony defects. [15]

13. MICROSURGERY IN IMPLANTS

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All phases of implant treatment may be performed using a microscope. Studies show that motor coordination and accuracy is generally increased when surgeons use a microscope.Although no studies establish that microsurgery reduces postoperative pain following extraction or implant placement, there is a strong theoretical rationale to suggest that less surgical trauma results in less pain and faster healing, and that microsurgery leads to those ends.Different stages of implant treatment ranging from implant placement to implant recovery and peri-implantitis management may be accomplished with more precision under magnification. One of the novel applications of microsurgery is in the sinus lift procedure with a success rate of 97%.The surgical microscope can aid indirect visualization of the sinus membrane and minimizes the risk of perforations. Incorporation of microsurgical techniques for an improvement of altered sensation due to implants encroaching on the inferior alveolar nerve even without unscrewing them has also been reported.[17]

14. ADVANTAGES OF MICROSURGERY

The advantages of microsurgery include increased precision in delivery of surgical skills, which results in more accurate incisions via smaller instrumentation, less trauma, and quicker postoperative healing, precise repositioning of tissues with smaller needles and sutures and improved view of root surfaces, which permits more definitive removal of calculus and improved smoothness of the root. [18]

15. DISADVANTAGES OF MICROSURGERY

Though there are multiple advantages, a few of the disadvantages of microsurgery include the surgery is much more demanding and technique sensitive, the cost incurred to establish a microsurgical set-up is also high. Magnification systems used also pose some difficulties including restricted area of vision, loss of depth of field as magnification increases and loss of visual reference points An experienced team approach mandates microsurgery and is time consuming to develop. Physiologic tremor control for finer movements intra-operatively and a steep learning curve are required for clinical proficiency. [18]

16. RECENT ADVANCES

Three dimensional on-screen microsurgery system: Current advances in video technology permit visualization of the (micro) surgical field on a video monitor three dimensionally without necessitating physical viewing through the microscope. The assembly of the three dimensional on-screen microsurgery system comprises of two single chip video cameras mounted on custom-fit eyepiece adapters, a dual camera-controller, a view/record image processor, a VCR for optional recording, digital monitor to enable viewing, synchronizing signal emitter, and 120 MHz shutter glasses (stereo eyewear). The development of this stereoscopic three-dimensional display technology proficient of providing a clear and accurate sense of depth perception was a boon for the rapidly evolving field of minimally invasive surgery. [19]

Entire Papilla Preservation Technique (EPP): In this technique, an interdental tunnel is made through the defect associated papilla by giving a bevelled vertical releasing incision in the buccal gingiva of the adjacent interdental space.After granulation tissue removal and root surface debridement, regenerative materials such as bone grafts and enamel matrix derivative are applied. Primary advantage of EPP technique is enhanced wound stability and limited premature exposure of regenerative biomaterials.[20]

17. CONCLUSION

As medicine and dentistry continue the pursuit of minimally invasive treatment, periodontal microsurgery and its principles will emerge as the methodology to meet professional and public demand. The microscope provides a tremendous platform from which the microsurgical clinician can gather and observe detailed and precise amounts of information for the diagnosis and treatment of patients with skill and accuracy. Microsurgery leads to improved aesthetics, rapid healing, reduced morbidity, and enhanced patient acceptance. Perusal of the data from the reviewed literature justifies that periodontal microsurgery seems to show promising clinical results along with an increased clinician as well as patient acceptance.As the benefits of magnification in periodontal surgical procedures are realized, its incorporation in periodontal practice at global level will become a treatment standard in the future.

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