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PERIODONTAL MICROSURGERY – A REVIEW

Dental Science

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ABSTRACT

Over the past decade, the field of periodontics has seen increasing surgical refinement of many procedures. Consistent successful periodontal treatment procedures demand clinical expertise that challenges the technical skills of periodontists to the limit of and beyond the range of visual acuity. Periodontal microsurgery is the refinement of basic surgical techniques made possible by the improved visual acuity gained with the use of surgical microscope. The effect of periodontal microsurgery may include more predictable therapeutic results, less invasive procedure with reduced patient discomfort, more rapid healing, improved cosmetic results and greater patient acceptance. The present paper insights into the history , magnification systems, and its indications in periodontal surgery and future perspectives.

KEYWORDS

Microsurgery, Periodontics, Surgical microscope, Visual acuity.

Introduction :

In the minds of many dental professionals, microsurgery is an interesting concept. Periodontal microsurgery is the refinement of basic surgical techniques made possible by the improvement in visual acuity gained with the use of surgical microscope.[1] In 1979, Daniel defined microsurgery in broad terms as surgery performed under magnification by the microscope.[2] In 1980, microsurgery was described by Serafin as a methodology- a modification and refinement of existing surgical techniques using magnification to improve visualisation, with applications to all specialties.[3] As a treatment philosophy, microsurgery incorporates three different principles[4]:

1. Improvement of motor skills, thereby enhancing surgical ability.
2. An emphasis on passive wound closure with exact primary apposition of the wound edge.
3. The application of microsurgical instrumentation and suturing to reduce tissue trauma.

The application of magnification to periodontics promises to change clinical concepts of periodontal surgical care. Now the patients expect sound advice and careful treatment. They readily appreciate advances that give more predictable, more cosmetic and safer results. Lessening their inconvenience, anxiety and discomfort is another advantage.

History

- In 1694, Amsterdam merchant Anton Van Leeuwenhook constructed the first compound lens microscope.
- Magnification for microsurgical procedure was introduced to medicine during the late nineteenth century.[5]
- Saemisch, a German ophthalmologist, introduced simple binocular loupes to ophthalmic surgery in 1876.
- In 1921, Carl Nylen, who is considered the father of microsurgery, first used a binocular microscope for ear surgery.[6]
- During 1950s, Barraquer began using the microscope for corneal surgery.[7]
- Apotheker and Jako first introduced the microscope to dentistry in 1978.[8]
- During 1992, Carr published an article outlining the use of the surgical microscope during endodontic procedures.[9]
- In 1993, Shanelec and Tibbetts presented a continuing education course on periodontal microsurgery at the annual meeting of the American Academy of Periodontology.

Types And Principles Of Magnification Systems[1,3,10]

Basically, there are two types of optical magnification systems available to dentists which include :

A. Loupes
B. Surgical Operating Microscope

A.Loupes

The most common magnification system used in dentistry is magnification loupes. Loupes are fundamentally two monocular microscopes, with side-by-side lenses, angled to focus on an object. The magnified image that is formed, has stereoscopic properties that are created by the use of convergent lens systems. Although loupes are widely used, their major disadvantage is that the eyes must converge to view an image, which can result in eye strain, fatigue and even vision changes with the prolonged use of poorly fitted loupes. Three types of loupes are commonly used:

1. Simple loupes.
2. Compound loupes.
3. Prism loupes.

1. Simple loupes - Simple loupes consist of a pair of single, positive, side-by-side meniscus lenses(FIG. 1). Each lens has two refracting surfaces, with one occurring as light enters the lens and the other when it leaves. Its main advantage is that it is cost effective.The disadvantages include : a)It is primitive with limited capabilities. b)They are highly subjected to spherical and chromatic aberration, which distorts the image of the object. c)Because of their size and weight limitations, they have no practical dental application beyond a magnification range of 1.5 diameters, where working distances and depths of field are compromised. d)When positioned close to the eye, simple loupes sacrifice depth of field for working distance. e)When positioned close to the object viewed, they sacrifice working distance for depth of field.

FIG. 1 – Simple Loupes

2. Compound loupes - Compound loupes consist of converging multiple lenses with intervening air spaces to gain additional refracting power, magnification, working distance, and depth of field (FIG.2).They can be adjusted to clinical needs without excessive increase in size or weight. Compound lenses can be achromatic, in addition to improved optical design.This is a feature that dentists should seek when selecting any magnifying loupe because an achromatic lens consists of two glass pieces, usually bonded together with clear resin. The specific density of each piece counteracts the chromatic aberration of the adjacent piece. These are commonly mounted on eyeglasses.

FIG. 2 – Compound loupes mounted on eye-glasses

3. Prism loupes - Prism loupes are the most optically advanced type of loupe magnification presently available.These loupes actually contain Schmidt or roof-top prisms that lengthen the light path through a series of mirror reflections within the loupe (FIG.3). They lengthen the light path by virtually folding the light so that the barrel of the loupe can be shortened. They are superior to other loupes in terms of better magnification, wider depths of field, longer working distances and larger fields of view.The barrels of prism loupes are short and can be mounted on eyeglasses or a headband. But the increased weight, at magnifications of 3.0 diameters or greater, causes headband mounted loupes to be more comfortable and stable than mountings on glasses.

FIG. 3- Prism loupes

Loupe Magnification

Wide ranges of magnifications are available in loupes, ranging from 1.5X to 10X. Loupes with less than 2X magnifications, are usually inadequate for the visual acuity necessary for microsurgery. For most periodontal procedures in which magnification is needed, loupes of 4X to 5X provide an effective combination of magnification, field size, and depth of focus.[1,11]

Adjusting Magnifying Loupes

Loupes are worn in a fixed position relative to the eye, presenting different problems in adjustment. Well adjusted loupes position the exit pupil right in the middle of the iris. If the exit pupil misses the centre and hits the edge of the iris, a crescent shaped portion of the field of view is cut-off and light is reduced. A clinician cannot simply move his head relative to the loupes and adjust this error. Instead, the clinician has to move the loupes relative to the eyes. If the error is small, and does not cause double vision, it may not be noticed. Uncorrected, the eyes will attempt to accommodate the error by converging, dilating and focusing. This causes fatigue of the ciliary and extraocular muscles and results in rapid eyestrain.

Choice Of Loupes

Before chosing a magnification system, different loupes and appropriate time for a proper adjustment have to be considered. Ill fitting or improperly adjusted loupes and the quality of the optics will influence the performance. For the use in periodontal surgery, an adjustable, sealed prism loupe with high quality coated lenses offering a magnification between 4X and 4.5X, either head band or front frame mounted, with a suitable working distance and a large field of view, seems to be instrument of choice.[12]

B. Surgical Operating Microscope[10,1,13]

The operating microscope offers flexibility and comfort superior to magnifying loupes. It is much more expensive and is initially more difficult to use. For use in dentistry, operating microscopes are designed on Galilean principles. They use the application of the magnifying loupes in combination with a magnification changer and a binocular viewing system, so that it employs parallel binoculars for protection against eye strain and fatigue. They also incorporate fully coated optics and achromatic lenses, with high resolution and good contrast stereoscopic vision (FIG.4). There must be an adequate working distance for instruments between the object being viewed and the microscope. To be able to use the microscope throughout the various areas of the mouth, it must also have extensive horizontal and vertical maneuverability with its attachment to the wall, ceiling, or floor mount. Surgical microscopes use co-axial fibre-optic illumination. This type of light produces an adjustable, bright, uniformly illuminated, shadow-free, circular spot of light that is parallel to the optical viewing axis.[1]

FIG. 4- Surgical microscope

Loupes Versus Operating Microscopes[1,10,14]

Loupes and optical microscope have some common features which include :

1) Both loupes and the operating microscope improve visual acuity and are beneficial in enhancing periodontist's ergonomic comfort and efficiency by increasing the optical working distance.
2) A multitude of eye, neck, shoulder, and back problems that are common to dentists assuming a shorter working distance to increase visual acuity without magnification, may be eliminated by using the surgical microscope.
3) Increasing the normal working distance by 6 to 8 inches has been shown to improve vastly the postural ergonomics and eye strain of industrial workers.

Advantages of loupes

- Less expensive and initially easier to use.
- Loupes also tend to be less cumbersome in the operating field and are less likely to breech a clean operative field.

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
- Countless accessories such as still and video cameras for case documentation.

Limitations of loupes[12]

- Lack of variable magnification, and that an individual light source may be required, particularly for magnification in the range of or greater than 4.0 diameters.
- With loupes, each surface refraction in a lens results in a 4% loss in transmitted light because of reflection, unless antireflective coatings are in place to counteract this by allowing the lens to transmit light more effectively. Compound and prism loupes without the protective coating could have as much as a 50% reduction in brightness.
- In spite of the great usefulness of surgical telescopes, there is one problem especially troublesome with the higher-power instruments. This is discomfort from the heavy weight which has to be borne by the surgeon's nose bridge. Many surgeons find the heavier instruments difficult if not impossible to wear for a long period of time.
- Higher power magnification often influences posture negatively if the focal length of the magnifiers does not allow the clinician to sit in a normal posture.

Limitations of operating microscope
- Restricted area of vision and loss of depth.
- Loss of visual reference points.
- A steep learning curve.
- Expensive to buy.

Benefits Of Microscopes In Periodontics[5]
Operating microscopes offer three distinct advantages to the clinician: Illumination, Magnification and Increased Precision in the delivery of surgical skills. Collectively, these advantages are referred to as the microsurgical triad. The surgical operating microscope, like all magnification systems, enhances visual acuity. This leads to:

- Increased precision in delivery of surgical skills, which results in more accurate incisions via smaller instrumentation, less trauma, and quicker post operative healing.

Gentle handling of soft and hard tissues with the same universally accepted surgical principles.

- Extreme and accurate wound closure.
- Little damage as possible to the tissues.
- Ergonomic advantage.
- Eliminates patient pain and morbidity to a great degree.
- It is perceived more favourably by the public than conventional surgery.

Microsurgical Instruments[1,5,10]
In addition to the use of magnification and reliance on atraumatic technique, microsurgery entails the use of specially constructed microsurgical instruments (FIG 5), specifically designed to minimize trauma. An important characteristic of microsurgical instruments is their ability to create clean incisions that prepare wounds for healing by primary intention. Proper instrumentation is fundamental for microsurgical intervention. Appropriate sets of steel or titanium instruments for periodontal surgery are available from different manufacturers. A basic set comprises of a needle holder, micro scissors, micro scalpel holder, anatomic and surgical forceps, and a set of various elevators. Several types of ophthalmic knives such as the crescent, lamellar, blade breaker, sclera and spoon knife can be used in the field of Periodontics. Ophthalmic knives offer the dual advantages of extreme sharpness and minimal size. This helps limit tissue trauma and promotes faster healing.[15] Because ophthalmic knives are chemically etched rather than ground, their sharper blades produce a more precise wound edge.[8]

FIG. 5 – Microsurgical Instruments

Microsurgical Needles And Sutures
Microsurgery has increased the Periodontists options for finer needles and sutures. An appropriate combination of properly selected needles and closure materials allows the surgeon to precisely position the suture and to approximate the tissue with as little trauma as possible while eliminating dead space and preventing movement of the wound. In the field of dentistry, particularly Periodontists frequently use a reverse cutting needle of significant size of 16mm to 19mm. Other forms such as spatula needle, which is 6.6mm in length and has a curvature of 140 degrees are used for accurate apposition closure and immobilization of connective tissue graft in microsurgery. The availability of smaller needles demands the need of different types of finer sutures. An accepted surgical practice in existing condition is selection of smallest sutures that adequately mend the tissues. Although 4-0 or 5-0 sutures are typically used in Periodontics, in periodontal microsurgery 6-0 and 7-0 sutures are appropriate.[1,10]

III. Microsurgical Indications In Periodontal Surgery
- Horizontal augmentation
- Vertical augmentation
- Guided tissue regeneration (GTR)
- Guided bone regeneration (GBR) and other procedures where increasing the amount of bone needs special preparation forms of the soft tissue
- Accurate split thickness flaps
- Double papilla flaps
- Apical or coronal repositioned flaps
- Connective tissue grafts
- Pedicle or sliding flaps

Applications In Mucogingival Surgery
All mucogingival surgical procedures are technique and operator sensitive and therefore tend to have varying therapeutic results. One way to achieve more consistent mucogingival surgical treatment results is to use microsurgical techniques and training, which itself has a long learning curve to obtain desired treatment end points. Historically, periodontal microsurgery has had its origins in the development of reconstructive gingival surgery. Most periodontists have found that gingival recession represented a significant cosmetic impairment, which through conventional surgical means, was difficult to return to normal appearance and function. Periodontal microsurgery has proven to be an effective means of improving the predictability of gingival transplantation procedures used in treating recession with less operative trauma and discomfort. Correct diagnosis, with microsurgical techniques, makes complete root coverage extremely predictable in class I and class II marginal tissue recession defects with a variety of procedures. The partial root coverage results achieved in class III and class IV marginal recession with conventional surgery can also be greatly enhanced through the use of microsurgery. Microsurgical principles and methodology application has made all gingival transplant procedures extremely reliable. The use of microsurgical approach makes even papillary reconstruction a realistic possibility.[1,10]

Improved Root Visualisation
Lindhe and co-workers (1984) suggested that the critical determinant of the success of periodontal therapy is the thoroughness of debridement of the root surface rather than the choice of grafting modality. Because stereomicroscopy is used to evaluate residual calculus on extracted teeth, it seems logical that a surgical operating microscope can enhance the operator's ability to see and remove calculus in vivo.[15]

Minimal Invasive Surgery (MIS) For Regeneration
MIS was introduced in 1999 by Harrel.[16] The salient difference between the minimally invasive approach and more traditional approaches for regeneration is in the use of much smaller incisions to gain surgical access and debride the periodontal defect prior to placing the bone graft and membrane.

Contraindications of MIS
o Generalized horizontal bone loss
o Multiple interconnected vertical defects.

Microsurgery In Implant Therapy
All phases of implant treatment may be performed using a microscope. One of the novel applications of microsurgery is in the sinus lift procedure. The surgical microscope can aid in visualization of the sinus membrane. Magnification achieved by the surgical microscope is instrumental in implant site development and placement.[17,18]

Drawbacks of microsurgery[19]:

As we upgrade our surgical maneuvers with the aid of microsurgical concepts, there are a few shortcomings of this modus operandi, which need to be considered prior to its application. It 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.

Future Perspectives: Robotic Microsurgery[20]:

Robotic microsurgery is taking over minimally invasive techniques in surgery. The delicate steps of operation are performed with the system that control instruments from 10 feet away inserted through small incisions. The surgeon manipulates the tele robot and watches the operation through a three dimensional video and is able to witness the precision that it delivers. It can also complete each step of the complex operation which was previously impossible. Future research in this field is required to incorporate this technique in dentistry.

IV. Conclusion

Optical magnification has broadened the horizons of dentistry in general and Periodontics in particular. The surgical operating microscope provides a microsurgical triad of illumination, magnification and an environment of increased precision in which surgical skills can be refined. Microsurgical periodontics is technique-sensitive and more demanding than periodontal macrosurgery, but it results in more rapid healing because it is less invasive and less traumatic. The improved visual acuity and ergonomics provide significant advantages. Periodontal microsurgery provides a natural evolution in the progression of periodontics.

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