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Review Report

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MAGNIFICATION SYSTEMS IN PERIODONTAL MICROSURGERIES

Rupali G. Shastri[1]* and Mangesh B. Phadnaik[2]

[1]Postgraduate Student in Periodontology, Govt. Dental Collage and Hospital, Nagpur.
[2]MDS Periodontology, Professor, Head of the Department of Periodontology, Govt. Dental Collage and Hospital, Nagpur.

***Corresponding Author: Dr. Rupali G. Shastri**

Postgraduate Student in Periodontology, Govt. Dental Collage and Hospital, Nagpur.

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ABSTRACT

Periodontal surgeries are the fruits of craftsmanship of the periodontists, with magnification systems being incorporated in the procedures enhancing the end-point appearances of the crafts. Like other surgeries, periodontal surgeries may also result into patient anxiety, discomfort, and post-surgical morbidities, along with clinical complications like delayed wound healing or microbial infections of the surgical sites. To overcome these possibilities, the science of surgery evolved into the concept of microsurgery, wherein the surgeries are performed in higher illumination and under greater magnifications. The magnification systems that have been reported in the literature of periodontology are the simple, compound, and prism loupes and the more complicated yet efficient surgical microscopes, with each of them having their own advantages and disadvantages. Due to higher resolution of the sites to the microscopic depths, the surgical motions shift from being guided proprioceptively to visually. This enhances the accuracy by permitting incision and flap reflection mappings more precisely, along with a tensionless wound healing with primary intention. This review focuses on the development and application of the various magnification systems feasible for use in periodontal microsurgeries, further refocusing the areas of potential research in the subject.

KEYWORDS: Magnification systems, Surgical microscope, Loupes, Periodontal microsurgeries.

INTRODUCTION

Eyeing back to 15th century, when the first idea of magnification was introduced, a proverb came into limelight, "you can do well what you see, if you see well what you do," which was and is utmost true to its sense. Periodontal health has been a major concern among the adult population worldwide, with the destructing periodontal tissues exerting a negative impact on normal activities of eating, speaking, and socializing, in general, on the overall quality of life.[1,2] Recently, treatment outcome in dentistry is largely being assessed from patient's perspective as the improvement in oral health-related quality of life.[3,4] For the establishment of periodontal health, surgical intervention has been the main stay of restoring the quality of life in moderate to severe periodontal conditions, and when compared with the non-surgical treatments, yields significantly better improvement in the outcome.[5] However, the para- and post-surgical concerns are more or less similar to any surgical intervention. To overcome the concerns, recently, the surgeries are being planned and performed at microscopic levels and the concept has been applauded well in various disciplines of medicine and dentistry. Yet, the promotion of the surgeries under magnification has still not paved fast in periodontology, and an inadequate insight into the magnification systems used in periodontology is one of the attributable reasons. Thus, we attempt through this paper to review and deliver an enhanced understanding about the various magnification systems used in periodontology.

Historical background

The first published data on the introduction of microscopes in dentistry dates back to 1970s.[6-9] However, the concept did not gain enough evidence and support till the 1990s, with the first published literature on microscopic surgery in periodontology being enlisted in 1993.[10] To widen the application of microscopes in periodontal surgery, the authors of the first publication, Shanelec DA and Tibbetts LS, started an educational course at an annual meeting in 1993 of the American Academy of Periodontology.[11]

The concept of magnification in periodontal microsurgeries

Periodontal miscrosurgical triad involves three basic components: magnification, illumination, and the periodontal microsurgical instruments. Magnification is the optical phenomenon of yielding amplified images, enabling an enlarged and intensified picture of the area under focus. The concept primarily aims at achieving precision in the periodontal surgery for a better clinical

outcome, by being able to view the surgical area under magnification by the magnifying loupes or the surgical operating microscope, although each bearing an own set of advantages and limitations. However, what remain in common among both the equipment used in periodontal microsurgery are the magnification and illumination of the surgical area, synergistically yielding an enhanced visual acuity and surgical precision.[12]

Determinants of efficient magnification in periodontal microsurgeries

The phenomenon and the extent of magnification depends upon the power of the eyepiece, the focal lengths of binoculars and the objective lens, and the magnification change factor. The principles of optics play an important role in the understanding of the concept of magnification.

Working Distance/Length

During the periodontal microsurgical procedures, an appropriate working length allows the surgeon to operate in a relaxed posture avoiding overextension of neck, chin, shoulders, or arms, and thereby fatigue and strain. This working distance is measured from the eye to the object in vision, and must not be <30 cm or >45 cm.

Depth of field

Likewise, the other determinant that avoids overextension or excessive leaning postures is the working range or the depth of field, which is the range within which an object remains in focus, in other words, the permitted range to zoom-in in the area of interest without losing the peripheral area mandatory to be seen during the surgery.

Width of Field/Field of view

The linear size or angular extent of an object that is visible through a magnification system during surgery greatly determine the efficiency of the surgical procedure. This greatly depends on the optical lens design, the working distance, as well as the extent of magnification. Thus, higher the magnification, narrower is the width of field. As a general view, most periodontal microsurgeons do not prefer to go beyond 2.5x magnification, in order to avoid unnecessary narrowing of the width of field.

Viewing angle

To allow a comfortable posture for executing the surgical procedures, an appropriate angulation of the optics is must. Lesser the viewing angle, more is the need to tilt the neck to view the area of interest adequately, thus compromising the comfort of working. Thus, the manufacturing of loupes to be used in periodontal microsurgeries require greater angulations than those acceptable for use in other purposes.

Convergence angle

An angle that aligns the lenses of both the eyes so as to focus at an identical point is most crucial to be designed properly as it determines the position of the extraocular muscles which are most prone to undergo fatigue during periodontal microsurgeries.

Magnification systems in periodontal microsurgeries

Magnifying loupes

Loupes, the commonest magnification system employed in dentistry, are basically two monocular microscopes or lenses placed on both the eyes to focus on a common object and project a magnified image onto the retina. Of all the loupes, the simple, compound, and prism loupes are the most commonly used for microsurgeries.[12]

Simple loupes

Simple loupes are one of the most primitive magnifiers, with a pair of meniscus lenses, with two refracting surfaces, one refracting the light at the entry in the lens and the other at the exit through the lens (Fig 1). Although, the lens are cheap and user-friendly, they have limited capabilities, with being prone to spherical and chromatic aberrations, distorting the image and color of the field of interest. Moreover, the working distance and depth of field are also not of acceptable values, making the lens not very popular in dentistry and so in periodontal microsurgeries. Furthermore, the size and weight of the lenses are additional discouraging factors for their practical use.[13]

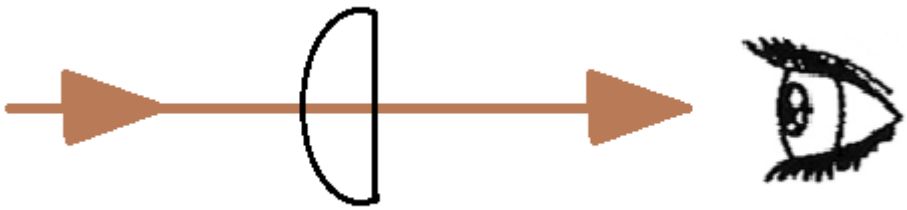

Figure 1: Diagrammatic representation of simple loupes.

Compound loupes

Compound loupes, also known as Galliean loupes, are sets of multiple lenses (Fig 2) with intervening gaps of air for additional refraction, magnification, working distance, and the depth of field. The light is thus allowed to pass through two converging lenses with intervening spaces. The additional lens is able to offset the color fringing and chromatic aberration of the adjacent lens.

However, they carry the disadvantages of emitting a halo effect at the periphery of the field of vision, lack of variable magnification, loss of around 4% of the transmitted light because of a reflective coating, and a need for an individual light source.[13]

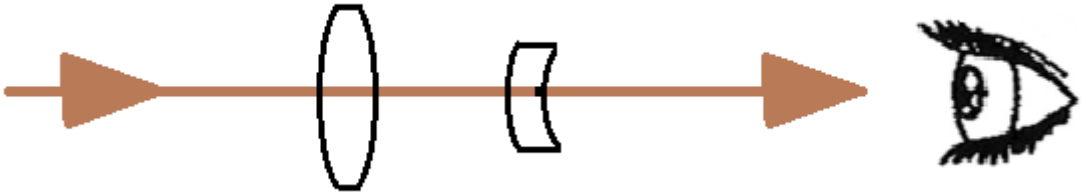

Fig. 2: Diagrammatic representation of compound loupes.

Prism loupes

Prism loupes are low power telescopes based on the Keplerian astronomical telescope, that consists of 7 lenses, raising the magnification to 10x. Thus, a sharper and clearer field of vision is provided, with high magnifications, wider depth of field, and a longer working distance as compared to that offered by other loupes. The loupes can generally be mounted on headbands or eyeglasses. Moreover, it consists of Schmidt prisms/roof-top prisms, lengthening the path of light through a series of reflections within the loupes (Fig 3), thereby further increasing the field of view, depth of field, and the working distance. However, as a drawback, the prisms and additional lenses add to the weight of the loupes and increase it by 30%-40%, also with around 40% increase in the cost, and an added concern of repair if any of the several components loosens or gets damaged.[13]

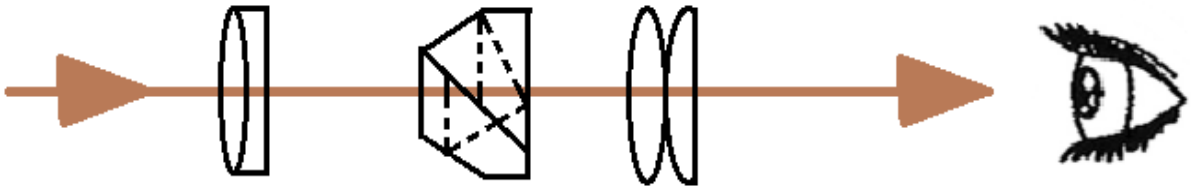

Fig. 3: Diagrammatic representation of prism loupes.

Surgical microscope

As an advancement of the magnification systems, surgical microscopes rendering a magnification as high as 40x and with a stereoscopic vision have been introduced as a boon to the field of microsurgeries. They are added with magnification changer, eyepieces, objective lenses, binocular tubes, lighting units (Fig 4), and also recently, cameras that can record the surgical procedures performed under the microscopes. The microscope can either be fixed to the floor or can be wall- or ceiling-mounted.[14]

Magnification changer

The magnification changer, also known as the "Gallilean" changer, assists the change of magnification to four different levels. This, with a combination of objective lenses and eyepieces, synergizes the magnification yielded by the microscope.[14]

Objectives lenses

The most frequently used objectives is the one with a focal length of 200 mm. The focal length of the objective determines the operating distance between the lens and the surgical field. A foal length of 175-mm focuses at about 7 inches, a 200-mm one focuses at 8 inches, and a 400-mm one focuses at 16 inches. The image processed by the magnification changer is projected through the objective lenses after deflection by the prisms unto the operation area.[14]

Lighting unit

Illumination being one of the components of the surgical triad, is advantageous for high magnifications. Lately, halogen lamps are being used for the purpose, with the advantage of providing whiter light than that provided by the conventional bulbs. However, to keep this infrared radiation from the operation area, cold-light mirrors are mounted on the microscopes.[14]

Binocular tubes

Binocular tubes are designed either straight or inclined, with straight tubes providing a view parallel to the microscope axis, while the inclined one at 45^{o} to the microscope axis, which are more preferable due to ergonomic reasons. Furthermore, the basic precondition for a stereoscopic view is a precise adjustment of the pupil distance of the binocular tubes.

Eyepieces

The eyepieces are further source of magnification for the image generated by the binocular tube. Eyepieces can be selected for various magnifications like 10x, 12.5x, 16x, and 20x, which not only determines the magnification but also the size of the field of view. Because both the magnification and the field of view are inversely proportional, a 10x eyepiece is the one that provides an acceptable compromise between both the components.[14]

Accessories

With the advancement of technology, the basic surgical microscopes can now be accessorized with video systems to produce quality slides and videos of the surgical procedure. The beam splitter, which provides the illumination for photographic and video documentation, can be connected to photo and cine adapters. The function of these adapters is to attach the 35-mm and video cameras to the beam splitter. Furthermore, a microcomputer inside the video printer automatically analyzes the image, and prints are created in 70 seconds by a high-density sublimation dye. Video prints can be used for patient education, medico-legal documentation or reports to referring dentists and insurance companies.[15]

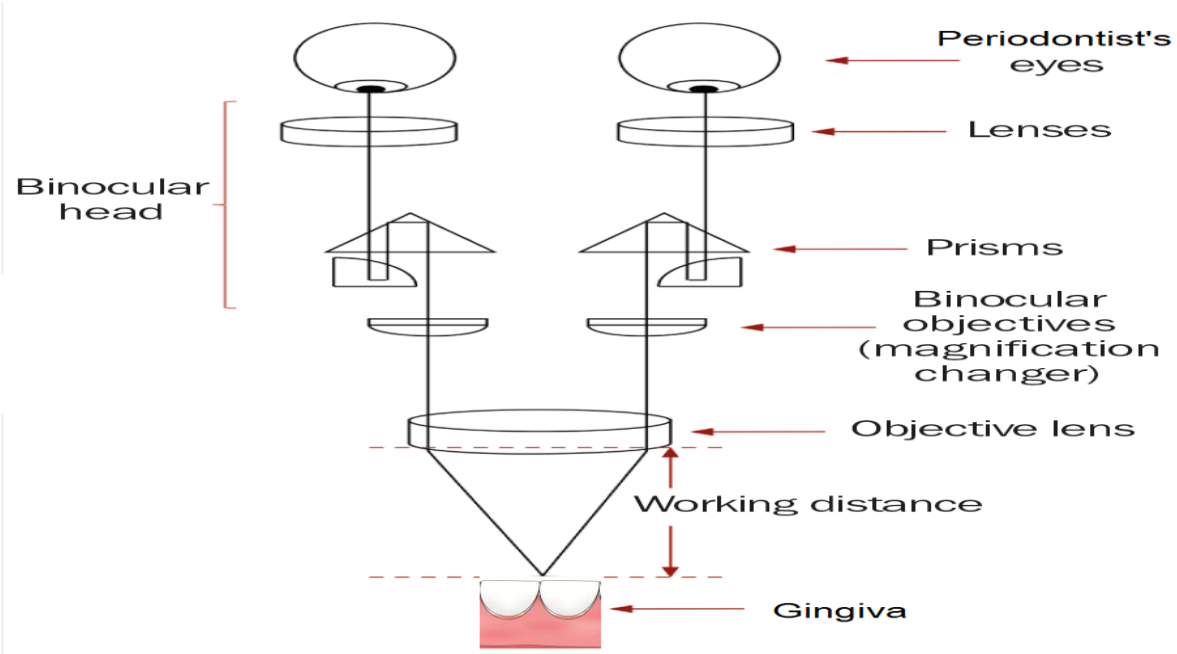

Fig. 4: Diagrammatic representation of surgical microscope.

Benefits of magnification systems in periodontal microsurgeries

Enhanced motor skills

Surgical microscopes can offer magnification up to 40x, under which surgeons get the liberty to anastomose even very small diameter (<1 mm) vessels. Interestingly, it has been documented that under a magnification of 120x, biologists can perform sub-cellular operations like those on the mitochondria and chromosomes. Visual guidance, rather than the conventional proprioceptive guidance, offers the ability of fine mid-course correction of hand movements with dexterity and skill.[16,17]

Enhanced accuracy

The enhancement of visual acuity bestows the advantage of more accurate mapping of incisions and flap reflections, along with more precise and tensionless wound closures. An advantage of the use of 6-0 and 9-0 micro sutures is also obtainable while closing the wounds under microscope. Overall, a better clinical outcome is obtained at the end of the therapeutic procedure.[17,18]

Better patient satisfaction

Because of the precision in giving incisions, working in the operating area, and acquiring wound closure, the postoperative patient morbidity is lesser than the conventional periodontal surgeries. The tolerance to the procedure by the patients is also higher because of a less traumatic and micro invasive kind of surgery, along with a reduced painful and inflammatory phase of wound healing and a high end-point therapeutic satisfaction expressed by the patients.[18,19]

Betterment of the periodontal craftsmanship

Microsurgery in periodontics is not a replacement of the existing artistic conventional periodontal surgeries. Rather, it is an enhancement of the craftsmanship, with it gaining a high acceptance among the periodontists and the patients, because of a far better end-point appearance after the surgery. It eliminates the gaps or dead spaces along the edges of the surgical wounds to circumvent the new tissue formation that can fill up the surgical voids. Studies witnessing the speed of recovery have documented an anastomosis of vessels at sites of microsurgical wounds as rapid as within 48 hours, with

primary wound healing and less granulation tissue formation. Thus, microsurgery is an evolution of the conventional surgeries, adding enormously to the craftsmanship of the surgeons along with their knowledge.[16-20]

Applications of magnification systems in periodontal microsurgeries

The use of magnification systems has greatly enhanced the efficiency of dental education as well the surgical therapies for gingival recessions, smile designing, restoration of edentulous ridge, root surface debridement, periodontal regeneration, crown-lengthening, implant placements.[21-26]

CONCLUSION

Magnification systems being employed in periodontal surgeries are nothing but evolutionary concepts in the conventional surgeries. Promising clinical results and satisfying patient experience advocate the application of the systems routinely. We recommend practitioners to apply the techniques and follow-up the patients mandatorily, followed by an effort to record and publish the results of the cases and studies for the perusal of clinicians and scientists.

CONFLICT OF INTEREST

None declared

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