

Microsurgery in Periodontics – A Review

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Abstract: Microsurgery in general is not an independent discipline, but a technique that can be applied to different surgical disciplines. First report on microsurgery is around 19 th century when the microscope is used in ophthalmology. Now, the microsurgery has laid its hands in the field of periodontics as it involves precise surgical procedures. This review deals with basics of periodontal plastic surgery including instruments involved in microsurgery, knot tying, clinical applications and microsurgical effects on aesthetics.

Keywords: Magnification loupes, microsurgery, mucogingival surgery, periodontal plastic surgery, surgical microscope

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I. Introduction

Microsurgery is broadly defined as the surgery performed under an operating microscope. Here the operating procedures are carried out under magnification beyond the range of simple loupes. This procedure is far beyond the normal range of unaided human capacities & skills and requires a special training and equipment.¹Daniel defined microsurgery in broad terms as surgery performed under magnification by the microscope.²“Macroscopic” is defined as visible with the unaided eye or without the microscope. Conventional macro surgery is therefore performed using normal vision without any magnification assistance. Over the last decade, periodontics includes procedures that require more detailed surgical skills. Guided tissue regeneration, cosmetic crown lengthening, gingival augmentation procedures, soft and hard tissue ridge augmentation, osseous resection and dental implants demand clinical expertise that challenges the technical skills of periodontists to the limits of and beyond the range of visual acuity²

1.1 Concepts In Microsurgery

The three elements, i.e. magnification, illumination, and instruments are called the “microsurgical triad”. Without any one of these, microsurgery is not possible.³MagnificationAn optimal vision is a key stone in periodontal practice. An important element to assess in human eyesight is visual acuity which is defined as the ability to perceive 2 objects separately. It states that how clearly the object under vision is clearly viewed. It’s a general fact that if a room is too dark and too bright we couldn’t perceive objects clearly and hence visual acuity decreases in low and high light density. Visualization of fine details is enhanced by increasing the image size of the object.

Image size can be increased in two ways:

1. By getting closer to the objects
2. By magnification.

In periodontal practice, the tissue to manipulate are usually very fine resulting in a situation in which the natural visual capacity reaches its limits. And hence the clinical procedure may only be performed successfully with the use of magnification improving precision and hence, the quality of the work.³Today wide ranges of simple and complex magnifying system are available which allows improvement in the accuracy of their clinical skills.³There are two types of optical magnification available to dentist:

1. Magnification loupes
2. The operating microscope

The latter can further be classified as:

- Single-lens magnifiers (clip-on, flip-up, jeweller’s glasses)
- Multi-lens telescopic loupes

1.2 Optical Principles

One should know the optical principles under which the loupes work under.

Working distance: Is the distance measured from the eye and the object in vision. Correct working length would never allow the overextension of neck, chin or by shoulders and it should usually ranges from 30 to 45 cm. **Depth of field:** Otherwise called as working range. It is the range within which the object remain in focus and hence the depth of field decreases as the magnification increases. Which means that as we zoom inside the area under vision is decreased so the surrounding area of defect is not under our vision. The depth of field of normal vision ranges from working distance to infinity. The proper depth of field will allow the clinician to avoid too much leaning and any overextension while practicing. (Figure 1) **Width of field /field of view:** It is the linear size or angular extent of an object when viewed through loupe system. Depends on the design of optic lens system, working distance and magnification. The higher the magnification, the smaller the width of field. Most periodontists find 2.5X magnification appropriate. **Viewing angle:** It is the angular position of the optics that allows comfortable working. Shallower the angle greater the need to tilt the neck to view the object being worked on. Therefore, the loupes designed for dental clinics should have a greater angulation. **Convergence angle:** It is the pivotal angle aligning two ocular lenses such that they point at the identical point, distance and angle. It defines the position of extra ocular muscles that may be important source of fatigue. (Figure 2).

Mechanism: Based on these principles there are 2 mechanism under which it works.

1. **Keplerian optics:** Here it has 2 lens where it angled to focus an object. Loupes works on this mechanics. (Figure 3)
2. **Gallilean optics:** It have binocular eyepiece which is joined by offset prisms to establish parallel optical axis & permit stereoscopic vision without eye convergence or eye strain. (Figure 4)

II. Visualisation For Microsurgery

Visualisation in microsurgery is employed through Loupes, microscopes and videoscope

2.1 Loupes

Loupes are the most common magnification system used in dentistry. Loupes are optical aids for magnified projection of an object on the retina. 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 system.⁴ Their major disadvantage is that eyes must converge to view an image, which can result in eye strain, fatigue & even vision changes with the prolonged use of poorly fitted loupes.⁵ Three types of loupes are commonly used.

2.2 Simple Loupes

It consists of a pair of single side by side meniscus lenses. These are primitive magnifiers with limited capabilities. Each lens has two refracting surfaces, with one occurring as light enters the lens and the other when it leaves. A disadvantage of such loupes is that they are highly subjected to spherical and chromatic aberration, which distorts the image of the object that is being viewed. It have no practical dental application beyond range of 1.5 diameter. Working distance and depth of field is compromised here.

2.3 Compound Loupes

It converging multiple lenses with intervening air spaces to gain additional refractory power, magnification, working distance and depth of field. Here the light passes through two converging with intervening air spaces.

2.4 Prism Loupes

It is the advanced type of magnification. These are low power telescopes which is based on keplerian astronomical telescope. It consists of 7 lenses and the magnification reach from 3.5 x to 10 x, hence the visual field is sharper and clearer. These produce better magnification, longer field of view, wider depth of field & longer working distance than other loupes. These microscopes can be mounted to headband or eyeglasses. It consists of Schmidt prisms / Roof top prisms which lengthens the light path through a series of mirror reflection within the loupes, thereby it increases the field of view, depth of field & longer working distance.⁶

2.5 Surgical Microscopes

Complicated system of lenses which allows binocular viewing of approximately 4x to 40x.⁷ These microscopes are capable of providing stereoscopic vision. These also provide stereoscopic vision and it can be fixed to the floor or mounted on the wall or ceiling. These consists of magnification changer, lenses objective, binocular tubes, lighting unit, camera through which recording each procedures also possible. Videoscope

The videoscope have been developed to overcome some of the difficulties which has been faced by current visualization procedures .It employs semiflexible glass fiber optic bundle which carries an image from the surgical site to the external camera which projects the image on the external monitor.⁸As it is semiflexible it cannot be sterilised and hence it is placed inside the disposable sheath or sheath which can be sterilised and this sheath has 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

2.6 Illumination

Periodontists are accustomed to lateral illumination from side-mounted dental lights. Clinicians who work with loupes often require a headlamp to compensate for the decreased illumination of dental loupes. Fiberoptic coaxial illumination is a major advantage of the operating microscope over surgical loupes. Coaxial lighting focuses the light parallel to the microscope's optical axis. With this, no shadows are produced. The surgeon can view perfectly the deepest reaches of the oral cavity, including into subgingival pockets & angular bony defects. Using the microscope, surgeons can view periodontal anatomy that previously could not be seen.⁹Most of the manufacturers offer collateral lighting systems or suitable fixing options. These systems may be helpful for higher magnification in the range of 4X and more. Loupes with larger field of view will have better illumination and brighter image than those of narrower field of view. Important consideration in the selection of an accessory lighting source are total weight, quality and the brightness of the light ,ease of focusing and directing the field of view of the magnifiers, and ease of transport between surgeries¹⁴ It should be realized that each surface refraction in a lens will result in a 4% loss in transmitted light due to reflection. In telescopic loupes, this could amount to as much as 50% reduction in brightness. Anti reflective coatings have been developed to counteract this effect by allowing lenses to transmit light more efficiently .This quality of lens coating also varies and should be evaluated when selecting loupes.¹⁰

III. Micosurgical Instruments

Proper instrumentation is fundamental for microsurgical intervention. With both magnification and microsurgical instruments we reduce tissue trauma &the bleeding.⁴The foremost characteristics of microsurgical instruments is to make clean incisions which is established at a 90 angle to surface using ophthalmic microsurgical scalpels.⁹

3.1 Classification Of Microsurgical Instruments

3.2 Magnifying instruments :

1. Loupes :

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

2. Operating microscope

3.3 Micro surgical instruments :

1. Microneedle holder
 2. Microforcep
 3. Microscissors
 4. Periodontal instruments
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1. Knives :
 2. Blade breaker
 3. Crescent
 4. Minicrescent
 5. Spoon
 6. Lamella
 7. Sclera
 8. Retractors and elevator
 9. Tying forceps :
 10. Platform
 11. Non-platform
 12. Micro needle and micro sutures

These instruments are made of titanium because of its strength, lightness and nonmagnetic characteristics and the working tips are much smaller than those of regular instruments.⁴As the instruments are

primarily manipulated by the thumb, index and middle finger, their handles should be rounded, so that finely controlled rotating movements can be executed.^{3,4} The instruments should be 18 cm long and should weigh around 15 to 20 gm in order to avoid arm and muscle fatigue. Microsurgical instruments have color coated surface in order to avoid the metallic reflection under the light of microscope. A basic set comprises of a needle holder, micro scissors, micro scalpel holder, anatomic and surgical forceps and a set of various elevators.^{3,4,10}

3.4 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 are 14 cm and 18 cm. The tips can be straight or gently curved, but the latter are 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.¹¹ A needle holder should ensure that a needle is held steadily without slipping. It should be light and require the 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.

3.5 Microforceps

Microforceps can make those manoeuvres that cannot be performed by hand. For example, the forceps can be inserted into the lumen of a cut vessel end to open the vascular lumen for needle insertion. The forceps used for vessel anastomosis are very fine and called dilators.¹¹ The most commonly used microforceps are 15 cm long, with round handles and 0.2- to 0.3-mm tips. There are different types of Microforceps for different operations.

1. Straight Jeweller Forceps
2. Curved Jeweller Forceps

Jeweller forceps are strong and cheap, with a variety of tips available. They can be straight or curved at different degrees, such as 45° or 90°. They are usually 11–12 cm long and suitable only for superficial operations. Their handles are flat, which makes rotating and changing the direction of the instrument less efficient.¹¹

3.6 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.

3.7 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.¹¹ Compared with the standard 15 blades commonly used in periodontics, the smaller size of the ophthalmic knives facilitates surgical work.¹²

1. Blade-breaker knife has a handle onto which a piece of an ophthalmic razor blade is affixed. This knife is often used in place of a no. 15 blade.¹⁴
2. The Crescent knife can be used for intrasulcular procedures. It can be used in connective tissue graft procedures to tunnel, to prepare the recipient site, or to obtain the donor graft.¹⁴
3. The Spoon knife is often used to undermine the lateral sulcular region in preparation for placement of connective tissue grafts.¹²

3.8 Micro Needles & Sutures

Three principle goals of surgery are¹²

1. Eliminating dead space,
2. Closing with sufficient but appropriate tension,
3. Immobilizing the wound
- 4.

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. Periodontist frequently use a reverse cutting needle a significant size (16 to 19mm). Although larger needles are sometimes indicated for periodontist, several needles allow more precise approximation of tissue edges. One such needle is a Spatula needle, which is 6.6mm in length and has a curvature of 140 degrees. Designed for ophthalmic surgery, the needle track is shallow and the needle purchase point is precise. These characteristics allow extremely accurate

apposition, closure, and immobilization of the connective tissue graft. Several other needles with sizes ranging from 6.6 to 19 mm can be used in periodontics.¹⁴

3.9 Basic Suturing Techniques

Suturing is basic to any approach in wound closure & flap control but even more so with the use of 4X or greater magnification. Accurate dissection & suturing of tissues under the microscope depends on visual feedback which is affected by:

1. Magnification
2. Lighting intensity
3. Glare
4. Color contrast
5. Other visual factors, such as visual health, binocularity, trained perception, skill, experience & fatigue.

When variable magnification is available, higher magnification is used to place sutures & lower magnification to knot the sutures. Basic to competent suturing is the availability of suitable suture materials, proper instrumentation & operator ergonomics. Finer needles & suture materials are used in microsurgery, which, in turn, demand precision miniaturized needle holders & tissue forceps to handle the tissue gently for precise positioning. A skilled microsurgeon uses proper basic suturing techniques & skills as a foundation for the advanced techniques.⁸

3.10 Suture geometry

1. Needle angle of entry and exit of slightly less than 90 degrees.
2. Suture bite size of approximately 1.5 times the tissue thickness
3. Equal bite sizes on both sides of the wound
4. Needle passage perpendicular to the wound

3.11 Knot Tying

Knot tying using the microscope is done using instrument ties, with a microsurgical needle holder in the dominant hand and a microsurgical tissue pick up in the non-dominant hand. Only the working tips of the instruments are visible in the microscopic field. Microsurgery is therefore done by visual reference only as the breaking force of microsutures is often less than the human threshold of touch. Micro-injury to tissues also occurs below the proprioceptive ability of the human hand. Well tied microsurgical knots are stable and resist loosening, even under functional load.⁶

Ethicon (1985) recommended the following principles for knot tying¹¹

1. The completed knot must be tight, firm and tied so that slippage wont occur.
2. To avoid of wicking of bacteria, knots should not be tied on incision lines.
3. Knots should be small and ends cut short (2-3mm)
4. Avoid excessive tension to finer gauge materials because breakage can occur.
5. Avoid using a jerking motion which may break the suture.
6. Avoid crushing or crimping of suture materials by not using haemostat or needle holders on them except on the free end for tying.
7. Do not tie the suture tightly cause tissue necrosis can occur. Knot tension should not produce tissue blanching.
8. Maintain adequate traction on one end while tying to avoid loosening the first loop.
9. The surgeons knot and square knot strength, although generally not needing more than two throws, will have increased strength with an additional throw.
10. Granny knots and coated and monofilament sutures require additional throws for knot security and to prevent slippage

One technique for holding the needle is to grasp the suture with tying forceps in one's non-dominant hand about 2–3 cm from the needle. Dangle the needle until it rests on the tissue and grasp the needle with the needle holder.²The needle should be set in the needle holder pointing along the intended path. Needle penetration should be perpendicular to the incision line. The needle should penetrate and exit the tissue at equal distances.¹¹ Depending on the needle diameter, the proper amount of tissue to engage is approximately 2 times that of the diameter of the needle. Engaging large amounts of tissue may not result in proper closure. The suture is best pulled through the tissue in a straight line perpendicular to the incision. Tying forceps can aid in this manoeuvre. Guiding the suture direction with tying forceps. Three common techniques are used in microsurgical tying: non-dominant, dominant, and a combination of the two. These techniques are best learned in a laboratory setting and are well referenced and described in detail in a Laboratory Manual for Microvascular and Microtubal Surgery. The non-dominant and combination tying techniques are the two most commonly used

in dentistry.¹¹ Square knots are the best to guarantee the integrity of the knot. A surgeon's knot followed by a square knot is the preferred knot combination. Adding excess ties to a knot does not increase its strength or integrity; it only adds to the bulk of the knot.

3.12 Ideal Needle – Thread Combination (Non -Resorbable) For Use In Periodontal Microsurgery

1) For buccal releasing incision following combinations can be used: a) A suture made up polypropylene (Prolene) of gauge 7-0, with the needle having a 3/8th curvature, cutting needle with precision tip and a length of 7.6 mm. b) A suture made up polypropylene (Prolene) of gauge 7-0, with asymptomatic curved needle, cutting needle tip with round body and a length of 8.9 mm. c) A suture made up polyamide (Ethilon) of gauge 9-0 with a spatula needle having a 3/8th curvature and a length of 5.2 mm. 2) In anterior areas interdental sutures can be placed with the following: a) A suture made up Polypropylene (Prolene) of gauge 6-0, with the needle having a 3/8th curvature, cutting needle with precision tip and a length of 11.2 mm. b) A suture made of Polyamide (Ethicon) of gauge 7-0, with the needle having a 3/8th curvature, cutting needle with precision tip & length of 11.2 mm.

3.13 Application In Periodontal Plastic Surgery

Today's plastic periodontal surgery, evolves from mucogingival surgery, includes all surgical procedures performed to prevent or correct anatomic, developmental, traumatic or disease – induced defects of the gingiva, alveolar mucosa or bone as given in Proceedings of the World Workshop in Periodontics, 1996. The application of plastic surgical principles to periodontal tissue comprises the field of periodontal plastic surgery. Periodontal plastic surgery, with its emphasis on aesthetics, is an important aspect of periodontal practice⁶

3.14 Types of Periodontal Plastic Microsurgery

There are two basic periodontal procedures in which periodontal plastic microsurgery may be applied:

1. those relative to the level of the dentogingival junction

those relative to the edentulous ridge. With regard to the dentogingival junction, microsurgery can be employed to add gingival tissue where it is absent or to remove gingival tissue where it is excessive. Periodontal plastic microsurgery of the edentulous ridge most often involves the addition of bone and or soft tissue.¹³

3.15 Esthetic Surgical Procedures

When we attempt to restore gingival aesthetics, several periodontal plastic surgery procedures are helpful, where it includes pedicle soft tissue grafts and free soft tissue grafts. The direction of transfer of the pedicle graft determines whether it is divided into rotational flaps (eg, laterally sliding flap, papilla flap, or double papilla flap) or advanced flaps without rotation or lateral movement (eg, coronally positioned flap). When we attempt using a guided tissue regeneration barrier, it is critical to maintain a space between the barrier membrane and the root surface for tissue regeneration.¹⁰ In attempting to correct small areas of recession without vast invasive procedure careful dissection and suturing is helpful.¹⁴ For subepithelial connective tissue graft we harvest graft from the palate by the "trap door"¹⁷ approach which is minimally invasive and heals rapidly. In this procedure we transfer donor tissue removed from one area of the mouth to a new microscurgically prepared recipient site allows for correction of gingival esthetic problems.¹⁸ Survival of the grafted tissue, whether the procedure is done macroscopically or microscurgically, is dependent on the recipient site having a blood supply to restore circulation to the transferred tissue.¹⁹

3.16 Root Surface Conditioning

As the root surface preparation deals with, how the soft tissue attaches to the root of the tooth in root coverage surgery, it is of the utmost importance. In an attempt to get new periodontal ligament attachment of a graft to the tooth with new cementum and Sharpey's fibers, several methods of root preparation have been proposed, including mechanical root preparation, chemical root preparation, and biologic root preparation.²⁰ The outcomes of some methods are based on histologic evidence and others on empirical observation, but all are important for successful root coverage.

Figures

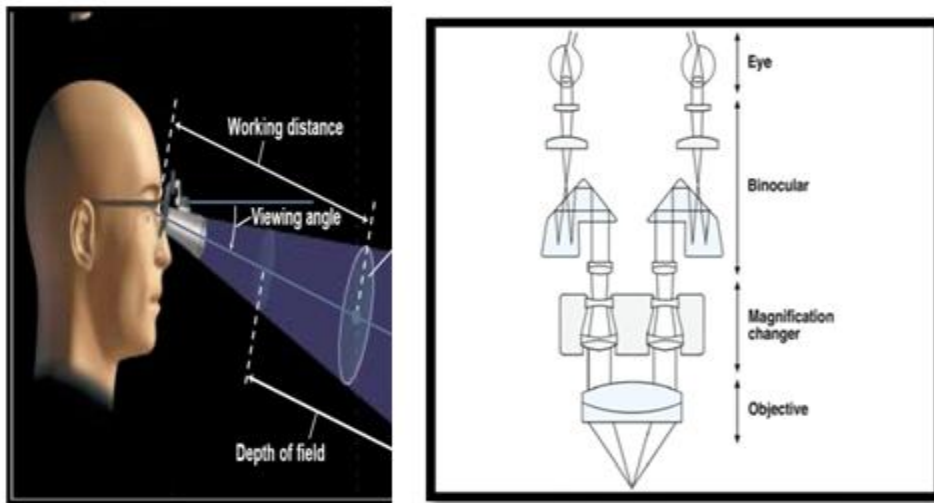


Figure 1 Optical principles of loupes

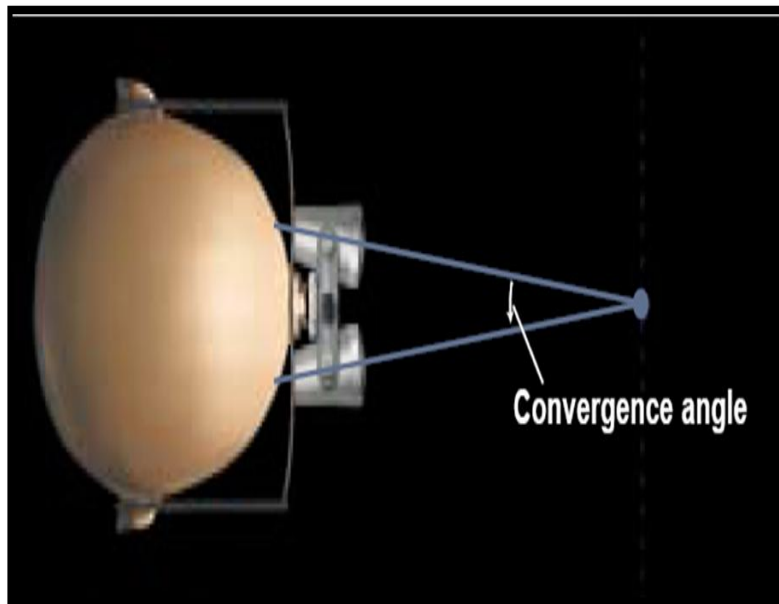


Figure 2 Convergence angle

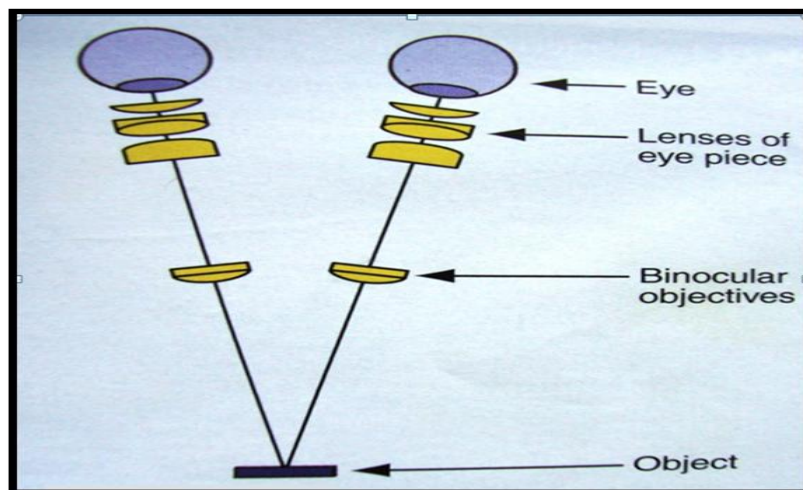


Figure 3 Keplerian optics

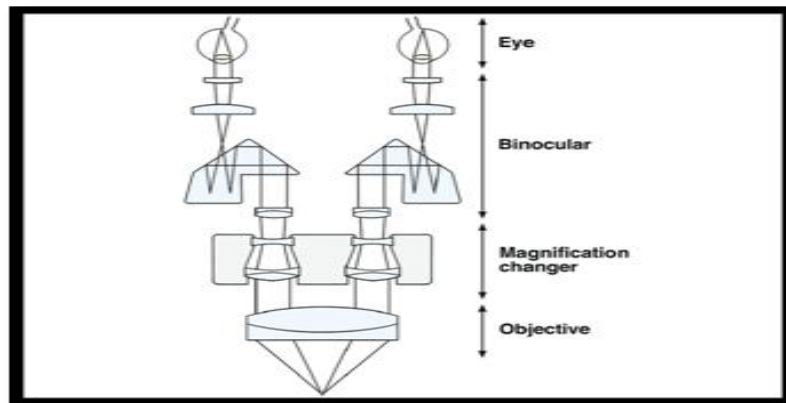


Figure 4 Gallilean optics

IV. Conclusion

Periodontal microsurgery is still in its infancy but the scope for it in future is enormous.²¹ It is a skill that requires practice to achieve proficiency of the highest level in the area to which it is applied. The miniature world of microsurgery presents special challenges in dexterity and perception which when mastered increases the innovative methods of treatment for better results. Its execution is technique sensitive and is more demanding than the conventional periodontal procedures.²² As the benefits of the microscopes are realized, it will be applied more universally. As public awareness of periodontal microsurgery increases, the conventional surgical approach with extensive incisions will become a less acceptable form of treatment. Microsurgery offers new knowledge and technology for periodontists that can dramatically improve the therapeutics results of many periodontal procedures like improved cosmetic results, rapid healing, and minimal discomfort and enhance patient acceptance. Dentistry of tomorrow will see increasing use of magnification in all areas of practice, including periodontics. Microsurgery will shift the focus of periodontal procedures from a macro to a micro field, thus achieving precise results with this technique.

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