SAGACITY ON DENTAL OPERATING MICROSCOPE – A REVIEW

Running title: Dental Operating microscope - review

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ABSTRACT:
The use of magnification devices in endodontics is mainly meant for visual enhancement and improved ergonomics. This is important especially when long hours are spent in a narrow operating space to treat minuscule anatomy. The utilization of magnification gives off an impression of being of expanding interest. With the ongoing advances of magnification devices with increased magnification and illumination, there is improved specialized accuracy and performance. A significant aspect of the modern endodontic armamentarium have focused light on high degree of magnification, the endoscope, dental loupes, and operating microscope. These advancements enables the operator to visualize even the tiny details for proper diagnosis and treatment of dental pathology. Despite the high cost, the use of dental operating microscope into the endodontic practice has improved the quality of treatment and ergonomics. To have a better understanding of the functioning of the magnifying devices, it is necessary to review some of the fundamental aspects of optics.

Keywords: Microscope, Magnification, visual, optimum illumination

INTRODUCTION

Endodontic visual loupes are more familiar in other medical specialties such as ophthalmology and neurosurgery. [1] The magnification needs in endodontic treatment range from 3X to 30X. [2] A SOM accommodates these magnification requirements. Although loupes can have magnification as high as 6X, they are not able to provide the same depth of field at 6X magnification compared with the microscope[3], and the fiber optic light source of the SOM provides two to three times the light emitted from a surgical headlamp.[4] Similar to loupes, the microscope uses the Galilean lens system. The eyepiece has an adjustable diopter setting ranging from – 5 to +5. The diopter setting helps the clinician focus the lens of the eyes and adjust for refractive error, which is the degree to which a person needs to wear corrective eyeglasses. [2] The structural components of microscopes are base on the mounting system and focusing parts of the operating site and other accessories. Gross focusing parts are binocular tubes, eyepiece, objective lens, illumination system, fine focusing part, magnification changer.

I -BASE OF THE MOUNTING SYSTEM [5, 6]

The base of the mounting system can be mobile floor stand and fixed ceiling or wall mount. The movable stand is essential if the microscope is used in more than one operating room or shared with another surgical service. An advantage of mobile floor stand offer the ability to carry more weight, has a longer reach on the carrying arm, and remove the problem of instability. A ceiling or wall mount may be superior to a floor mount if the surgeon always operates in the same room and the microscope need not be moved elsewhere, or if the operating room is small and difficult to accommodate a microscope with a mobile floor stand. Advantages are they can be mounted on a motorized track on the ceiling, allowing the ceiling-mounted microscope to be positioned according to the site of operation, or to be backed into a corner of the room, when not needed. They offer exceptionally fast set up time and minimize space crisis. [5, 6]

II -MOUNTING SYSTEMS [6]

Good mounting systems improve the handling of the microscope and minimize unwanted motion.

They should position the microscope both vertically and laterally over the surgical field. The movement to a new location should be easy. The vertical position must allow for coarse adjustments and fine focus. Stability is needed so that slight pressure on the surgeon's eyepiece does not shift the position. Microscopes are mounted on various types of stands; manual design rotating arm design uses a series of arms rotating about a horizontal plane, to position the scope over the field. Height is adjusted along a vertical pole. [6] Motorized stands are controlled by hand or foot switches that unlock electromagnetic couplings to make the microscope movable. It can be adapted to both floor and ceiling mounts. [6]

III - FOCUSSING PARTS

The function of the binocular is to hold the eyepiece. The interpupillary distance is set by adjusting the distance between the two binocular tubes. Once this distance is set, it should not be changed until a surgeon with different optical requirements uses the microscope. Shorter length binoculars allow the operator to have a wider field of view and to be a little closer to the patient. [7]

A) Straight Tube Binoculars are familiar to endodontics because they allow the operators to look through the microscope directly at the surgical field. Straight tube binoculars have the advantage of direct vision in both maxillary and mandibular arches. [2]

B) Inclined Binoculars are oriented in such a way that tubes are offset at 45° to the head of the microscope. In maxillary surgery, inclined tubes could be used but the operator would use a mirror for indirect vision or head position of the patients to be side while performing mandibular surgery. [2]

C) Inclinable binoculars are adjustable between the straight tubes and slightly beyond the inclined tube positions up to and sometimes beyond 90° and even up to 180 degrees. Inclinable tube binoculars can often provide the operator with additional postural comfort during longer procedures. The only disadvantage of inclinable tube binoculars is that they are difficult to engineer and can be quite costly. [2]

D) Eyepiece fit into binocular tubes. They are generally available in powers of 6.3X, 8X, 10X, 12.5X, 16X, 20X.[5] Modern versions of eyepiece screw into the binocular tubes rather than push- in type (which were used in older versions). This ensures that incorrect positioning of the eyepiece in the binoculars is avoided. The viewing side of an eyepiece has a rubber cup which is turned down if the surgeon wears glasses. [2]

E) Objective Lens is a lens whose focal length determines the working distance between the lens and the operating field. A variety of objective lenses are available with focal lengths ranging from 100-400 mm. A 175 mm lens focuses at about 7 inches, a 200 mm lens focus at about 8 inches, and a 400 mm lens focuses at about 16 inches. The 200 mm objective lens is recommended for endodontic surgery because this distance provides adequate room between the “surgical” filed and objectives lens for surgical instruments and constitutes comfortable working distance.

F) Illumination System with an operating microscope is coaxial with the line of sight. Clinician can look into the surgical site without seeing shadows, where light is focused through eyepieces. This is made possible because the operating microscope uses Galilean optics. Intensity is controlled by a rheostat and cooled by a fan. [6]

TYPES OF ILLUMINATION

Two different types of illumination are possible with surgical microscopes in coaxial Illumination the light is deflected from the exit surface of the light guide to the exit prism via deflecting prism. The exit prism also has a collective effect which together with the main objective lens produces a field of illumination. It is possible as operating a microscope uses Galilean optics which focuses at infinity sends parallel beams of light to each eye.[8] Paraxial illumination, on the other hand, mainly offers benefits with flat surgical fields, as this type of illumination allows the prevention/elimination of reflections from the surface. [6]

Illumination Devices

Two light source systems are commonly used as Xenon Bulb (Most Recommended), Quartz Halogen Bulb in fiber optic.

1] Xenon Bulb

It is brighter and warmer than the Quartz Halogen bulb and produces light almost comparable to daylight. It has a color temperature of 5600 degrees K and produces a true-color picture. For the photographic purpose, they need daylight film. [8]

2] Quartz Halogen Bulb

Fiber optic cables absorb light and tend to be light deficient. It has a color temperature of 3200k° and produces a yellow picture & for photographic purpose, they need a tungsten film. The intensity of the light is controlled by a rheostat, and the lamp is cooled by a fan.

Path of light through Microscope

After light reaches the surgical field, through an objective lens it is reflected, into magnification lenses. Then it exits to the eyes as two separate beams of light. This light beam is what produces the stereoscopic effect that allows the clinician to see the depth of field. [8]

(II) FINE FOCUSSING PARTS OF THE OPERATING SITE

Magnification Changer:

The magnification changer increases or decreases the total magnification of the objective lens. Magnification changes are available as either -

A) Three or Five-step Manual Changers

- It consists of lenses that are mounted on a turret.
- Dial positions, one lens in front of the other within the changer to produce a fixed magnification factor.
- The power of eyepiece, the focal length of the binoculars, and the focal length of magnification changer lenses are factored in, three fixed powers of magnification are obtained, two from each lens pair combination and one from blank space.
- Blank space produces magnification by factoring only the eyepiece, the focal length of binoculars, and the focal length of the objective lens.

B) Power zoom Changer

It is merely a series of lenses that move back and forth on a focusing ring to pair a wide range of magnification factors. They avoid the momentary visual disruption or jump that occurs with 3 to 5 step manual changes as the clinician rotates the turret and progresses up or down in magnification

IV- ACCESSORIES:

Many accessories have been made for the operating microscope. Most of these allow surgeons, assistants, nurses, and others to observe images of the operation while it is in progress and for documentation. [9]

A) Beam splitter Two systems are included in each beam splitter, one dividing the left and the other dividing the right optical pathway. The beam splitter takes a certain percentage of light away from the original path. The 50:50 beam splitters divide equally between the surgeon and the observer. A 60:40 unit sends 60 % light to the surgeon and 40% to the other pathway. The choice of percentage depends on the amount of available light and light needs of the accessories. [10]

B) Photo Adapter, 35 mm Still Camera, Television Camera, Video camera, Auxiliary Monocular or Binocular Viewing Tube. A photo adaptor with a light intensity control may be placed between the beam splitter and these accessories. Another accessory used to facilitate assistant viewing is Liquid Crystal Display (LCD) screen. The LCD screen receives its video signals from a video camera. When viewing an LCD screen, the assistant sees exactly what the surgeon sees without having to take his or her eyes away from the surgical field. This viewing system has an advantage over the articulating binoculars because the assistant doesn't have to move away from the microscope if the surgeon must move the microscope during surgery.[9] Two accessories, one on each side of the beam splitter, are commonly used. The surgeon may desire three or more accessories such as a combination of a still 35 mm camera, TV camera, observer tube. An observer tube optical switch, built to accommodate two accessories, may be attached to either of the two parts of the beam splitter. Adjusting the switch directs the image to other but not both of the accessories. It requires great demand for the lighting systems. They have been met by fibro-optic cables attached to a powerful light source. Ideally, four accessories could be used if beam switches are placed on each side of the beam splitter. The attachment of

multiple accessories.[9]

C) Handle pistol grips or bicycle-style handles can be attached to the bottom of the hand of the microscope to facilitate movement during surgery.[9] A dental operative microscope not only useful in the endodontic procedure but also useful in restorative procedure with composites resins. Since composite resins are tooth-colored marginal adaptation can be challenged with the naked eye. Poor marginal adaptation combined with polymerization shrinkage can affect the longevity of the restoration.[11] Polymerization shrinkage of the nanohybrid composite due to variation in the curing distance and the time gap in the curing cycle therefore dental operative microscope are very useful in obtaining a proper tooth - restoration margin [12]

CONCLUSION:

The advent of microscopes is to achieve the highest precision possible while providing healthy tissue with optimum protection. Above all the microscope can be a valuable patient education, practice enhancement, and self-appraisal tool, for improving the overall quality of work in day-to-day practice. This means less suffering for patients, faster recovery periods, a higher chance of obtaining the desired outcome and improved long-term outcomes. Undoubtedly, microscopes has proven beneficial results in therapeutic aspects of dentistry and still many more new horizons are yet to be reached using surgical microscopes in endodontics.

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