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Magnification in Endodontics- Recent Advancements- Review

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ABSTRACT

Conventional Way of Endodontic Treatment Is Based upon Feel Not the Sight; the field of endodontics has witnessed significant technological advances over the past decade. One area of advancement has been the evolution of endodontic visualization. Magnification Increases The Ability Of Operator To Visualise Even The Smallest Detail For Proper Diagnosis And Treatment Of Dental Pathology. This article will discuss the use of loupes, microscopes, endodscopes and orascopes in endodontic treatment.

KEYWORDS: Magnification, loups, microscope, endoscope, orascope.

INTRODUCTION

Visualization of surgical and conventional endodontic treatment has historically been limited to the two-dimensions of a dental radiograph that is representative of a three-dimensional biological system.[1]finding the path of entry to and exit from pulp space and hermetic seal after debridement is the basic in endodontics. A better illumination and superior magnification is required for better endodontics.[2]The integration of optical magnification instruments such as loupes, microscopes, endoscopes and or a scopes in to the endodontic treatment equipment, facilitates the dentist to magnify a specific field of treatment beyond that of the naked eye. [1]

OPTICAL DEFINITIONS

Working distance: The distance measured from the dentist's eye to the treatment field being viewed.

Depth of field: The amount of distance between the nearest and the farthest objects that appear in acceptably sharp focus.

Convergence angle: The aligning of two oculars in order that they are pointing at the identical distance and angle to the object or treatment field.

Field of view: The area that is visible through optical magnification.

Viewing angle: The angular position of the optics that allow for a comfortable viewing position for the operator.[1]

LOUPES

The most commonly used magnification system in dentistry are Dental loupes. [1,3]Magnifying loupes were evolved to prevent 111111the problem of proximity, decreased depth of field, and fatigue of the eyes. Loupes are categorized based on the optical method in which they magnify the object. The following are the three types of binocular magnifying loupes: 1) a diopter, flat plane, single lens loupe, 2) a surgical telescope with a Galilean system configuration 3) a surgical telescope with a Keplarian system configuration. [4]

Convergent lenses are used in all kind of loupes to form a magnified image.[3] single lens loupe system is the simplest form of optical magnification (i.e., jeweler's flip-down magnifiers) which has a fixed focal length and working distance.[5] The advantages to these types of loupes are low cost and lightweight since they are made out of plastic. These types of loupes are lightweight since they made up of plastic. The advantages of this system are inexpensive and not heavy. the poor image resolution as compared to multi-lens glass optics is the disadvantage of single lens loupes.[6] the dentist may find the ergonomics incorrect and may need to compensate with poor body posture which will lead to neck and back strain while performing a procedure as the single lens loupes provide a set working distance

Multi-lens optic system is evolved to overcome the disadvantages of single lens loupe optics. This kind of glass multi-lens configuration is called as a Galilean optical system [Figure 1]. It imparts a higher level of magnification, enhanced depth of field and working distance along with greater optical resolution in contrast to single plastic lens optics.[5]Galilean optics is used in Telescopic loupes. Telescopic loupes provide the magnification of ×2.5. This imparts a good compromise between optical performance, weight and cost.

Silber suggests the use of ×2.5 operating loupes since the loupes magnification with greater than ×2.5 limits the depth of field and working distance during treatment. The loups with higher than ×2.5 magnifications can be distracting and irritating while operator is moving as it will cause a treatment field to come in and out of focus.[7]

Prism optics is used for higher magnification is (up to ×6). This optical system works based on the Keplarian astronomical telescope which uses two prisms and five lenses. Superior optical clarity and flatter view from edge to edge are the advantages of this system. Whereas heaviness and high cost are the disadvantages.[6]Loupe manufacturers have designed portable clip on source of light[1]as the magnification in loupes increases, the need for more illumination is required.[8]

However the major drawbacks of magnifying loups are the following. Only about 4.5X magnification can be achieved in clinical conditions. Loupes with higher magnification are bulky and unhandy with limited field of view.[9]

MICRO SCOPES

In the literature the use and advantages of the operating microscope for conventional endodontics was first reported byBaumann.[10]In 1991, Gary Carr introduced an operating microscope with Galilean optics to achieve greater magnification than loupes. This was ergonomically arranged for dentistry with various benefits which facilitated the use of scope during almost all endodontic and restorative procedures .[11]In surgical and non-surgical endodontic treatment formal microscope training was made as mandatory by the American Dental Association from January 1, 1998.[12]

Parts of operating microscopes:

Three main parts of head of the microscope:

1) Body tube optics
2) Eye piece lens
3) Objective lens

Eyepiece: it has a major role in magnification. The focal length & the magnification change factors together, impart the desired magnification.

Binoculars: holding the eyepieces is the function of binoculars. An intermediate image is projected into focal plane of the eyepieces by the binoculars. It is available in different focal lengths. Magnification is higher and field of view is narrower if the focal length is Longer.[13]

Objective lens: the operating distance between the lens and the surgical field is determined by the focal length of objective lens. Focal lengthsavailable for objective lenses are ranging from 100 to 400 nm.[14]

The microscope also uses the Galilean lenssystem similar to loups. The magnification power of the eyepiece, the focal length of the binoculars, the magnification changer factor and the focal length of the objective lens are the determining factors of magnification of the surgical operating microscope (SOM).[15]

In the literature, it is well documented about the advantages and usage of SOM for optical magnification in conventional endodontic therapy. In conventional endodontic treatment, the enhanced and magnified visualization aids in locating the canals, management of calcified canals, removal of separated instruments, perforation repair, diagnosis of micro fractures and case documentation [16, 17, 18, 19, 20]

The magnification required in endodontic treatment usually range from ×3 to ×30.[15] In spite of the fact that loupes can have a magnification as high as ×6, they are not able to give the same depth of field at ×6 magnification when compared to the microscope. The fiber optic light source of the SOM provides 2‑3 times the light emitted from a surgical headlamp.[7, 21]

Requirement of fewer radiographs during the surgical procedure, Improved view of the surgical operating field and the documentation of the treatment are considered as the advantages of SOM in surgical endodontics.[22]

Saunders et al. states positional difficulties, inconvenience and increase treatment time are the most common reasons for endodontists not using the SOM.[16] Furthermore, dentist requires special training to use SOM and this microscope is very expensive which requires regular maintenance.[23]

ROD‑LENS ENDOSCOPE

In the literature, the use of a rod‑lens endoscope in endodontics was first reported in 1979.[24]It comprises of monitor, light source, rods of glass work injunction with a camera. For the documentation procedure, a digital recorder (either still capture or streaming video) can be attached. It provides greater magnification for the dentist than the loupes or a microscope with the same level of optical resolution compared with the microscope or loupes. Bulkiness and difficulty in maintaining the fixed field of vision are the disadvantages of rod-lens endoscope when compared to a microscope.[25]

The utilization of the endoscope is, consequently, recommended for visualization of surgical endodontic treatment.[26]With the use of endoscope, dentist can achieve non-fixed field of vision to view a surgical treatment field. This is defined as the ability to view a treatment field at various angles and distances without losing depth of field and focus. This property is considered as an advantage of endoscope over the microscope.[25]

As the scope cannot produce a noticeable image in the presence of blood, obtaining the homeostasis of the surgical field is mandatory before placing the endoscope in the field of treatment. Condensation may occur on the lens due to the warmth of the blood. This fogging effect can be avoided with the help of suction and irrigation or application of an anti‑fogging agent on the lens. To stabilize the scope, it should be placed on bone around the crypt. To provide stability and rigidity to the scope, it has to be covered with a protective metal sheath.[1]

ORASCOPE

An or a scope is a kind of endoscope which is made up of fiber optics. Similar to rod‑lens endoscope it functions injunction with a monitor, a camera and light source. Fiber optics are made of plastics, and therefore, are small, lightweight, and flexible. Fiber optics is small, lightweight and flexible as these are made-up of plastic. The number of fibers and size of the lens used are the determining factors of image quality. The fiber optic endoscope is indicated for intra-canal visualization.[27]

The range for depth of field of an or a scope is 0 mm to ∞. Due to this feature even if the scope is not reaching the apical area of the canal also, it can capture the apical third of the root. Before placing the 0.8 mm fiber optic scope, it is recommended that usage of SOM or 2‑2.5 × loupes for endodontic visualization during the access cavity preparation. For proper placement of the or a scope into the canal, the coronal 15 mm of the canal must be prepared to a minimum size of a #90 file. Otherwise, wedging of the or a scope may occur which in turn leads to damage of some of the fiber optic bundles within the scope. Although, the scope can see through sodium hypochlorite, the canal must be dried with paper point before placing the scope as this solution has a high light refractory index. High light refractory index will lead to higher amounts of light that will be reflected, which will make the details of the canal difficult to see. Condensation may occur on the lens due to the temperature and humidity difference between the dental operatory and the canal. The use of a lens anti‑fog solution can help to prevent this fogging effect by eliminating this lens condensation build up.[1]

MAGNIFICATION VERSUS DIFFERENTIATION

Magnification is defined as making an object or treatment field greater in size. Differentiation is defined as making something distinct or specialized.[28]Differentiation in magnified field is important in conventional endodontic therapy when suspecting a fracture or in surgical endodontics when trying to identify the periodontal ligament (PDL), marginal leakage around a previous root‑end filling material or an isthmus. Methylene blue which is nontoxic and biocompatible dye can be used in conjunction with endodontic visualization equipment to help in differentiate an operating field in order to aid the endodontist in identifying the etiology .[29]

CONCLUSION

Any equipment that aids in diagnosis and operating procedure is appreciated. However, the success depends upon our commitment to achieve perfection and excellence. If we make a genuine effort, we can find ourselves rejuvenated and endodontics more enjoyable.

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Figure 1: