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Role of magnification in endodontics

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Abstract

Excellence in dentistry is both a choice and a journey, and magnification can be a powerful asset for those who seek absolute clinical accuracy.The operating microscope has revolutionized the speciality of endodontics. It represents a qualitative leap for the profession. Magnification and coaxial illumination have enormously increased the possibility of saving teeth both nonsurgically and surgically.

Keywords: Loupes, Microscope, Orascope, Endoscope

Introduction

The art of dentistry is based on precision. The human eye may not be able to achieve the requisite precision on all occasions .Visualizing the oral cavity , more so the morphology of the pulp spaces, always pose a challenge to the clinician.

The unaided human eye can visualize only upto 0.2mm. This means that when two lines are drawn parallel to each other with a distance of 0.2mm between them, the human eye can visualize two separate lines. If the separation is less than 0.2mm, the eye will detect it as a single line.

Since long higher magnifications have been used to study cell growth, mutation etc. The magnifying devices such as loupes, microscopes, endoscopes enhance the working site as well as the posture of the clinician.

History

In 1922 Carl Nylen introduced Monocular microscope .In 1953 Carl Zeiss introduced Binocular operating microscope. In 1981 Apotheker introduced the first dental operating microscope .Noah chivian , an endodontist introduced 8x microscope in the field of endodontics.Dr Carr introduced the first ergonomically configured operating microscope for routine endodontic procedures. He is aptly known as the "Father of microscopic endodontics".

Dr Carr"s statement " you cannot treat what you cannot see" has inspired a great number of endodontists.

Optical Definitions

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

Depth of field : Refers to the ability of the lens system to focus on objects that are both near and far without having to change the loupe position.

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

Viewing angle: The angular position of the optics allowing for a comfortable viewing position for the operator.

Convergence angle : Aligning of two oculars pointing at the identical distance and angle to the object or the field.

Declination angle: the angle of operator"s eyes that is inclined downward toward the work area

Magnification types

Loupes: Dental loupes are the most common magnification system used in dentistry.. Loupes , also referred to as telescopes, are usually used magnification device in dentistry. The loupes allow working with less than 25 degrees forward movement of head leading to less muscle fatigue.

Three types of loupes

- **Flat plane (single lens) loupe :** It consists of a single lens, and is fairly inexpensive.
- **Galileian lens (two lens) loupe :** this is a two lens system providing a magnification of 4.5x
- **Prism loupe:** these are the most advanced loupes providing a magnification of 6x. The lens can be flipped during the procedure. They provide a larger field of view from longer distance thus minimizing stress factor.

Advantages

- Easy manipulation
- Inexpensive

Disadvantages

- Maximum magnification is 6x
- Higher magnification loupes are heavy (flip-up loupes)
- Image is not stable due to head movement
- Prism loupes produce better magnification, larger fields of view, wider depths of field, and longer working distances than other types of loupes.
- Only the Dental Operating Microscope (DOM) provides better magnification and optical characteristics than prism loupes.

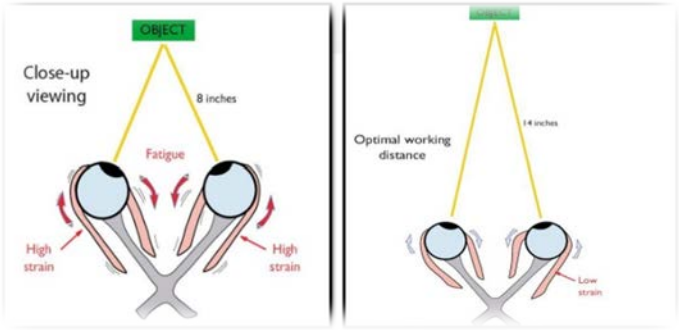

Figure 1

Dental operating microscope

- In current times the Dental Operating Microscope is widely used by Endodontics all over the world as it provides the best magnification and illumination for dental procedures.

Classification: based on use

- Surgical microscope
- Examination microscope

Based on magnification

- Lower magnification (2.5x to 8x)
- Midrange magnification (8x to 14x)
- Higher range magnifications (14x to 30x)

Three primary structures of the operating microscope

1) Magnification

a) eyepiece

b) binocular

c) magnification changers

d)objective lens

2)illumination

3)accessories

Total magnification of the microscope

- TM = (FLT/FLOL) × EP × MV
- FLT: Focal length of binocular tube
- FLOL: Focal length of objective lens
- EP: Eyepiece Power
- MV: Magnification Value

It is important to keep in mind that maximum magnification is used to check, and most of the procedures are made at minimum-medium magnification

Documentation

Quality slides and video proportional to quality of magnification & illumination

Advantages

• Communicate with referring dentist

• To educate patients and students

• To maintain required legal documentation

- Postural: Posture should be perfect. Avoids tiring of eyes, no need of wearing prescription eye wear.
- Procedural: improves manual abilities. collateral vision decreases. Procedure recording can be done. Procedural errors can be assessed.
- Psychological: Decreases psychological, physical, postural stress. Increases personal and professional satisfaction.
- Educational: Easy for us to gather images to file. Procedures can be recorded and can be presented in symposia and conferences.

Advantages of DOM

- Detailed view of the root canal intricacies enabling the operator to be more precise.
- Magnification obtained from 2x to 20x or even more
- Solve many problems related to posture
- More relaxed eye position as they eliminate the need to converge the eye
- Coaxial illumination is obtained
- “Work satisfaction” in practice
- Documentation benefits from attachments in the form of digital photography and video productions

Disadvantages of DOM

- As magnification increases, the size and depth of field decreases.
- Indirect vision with mirrors is inevitable in non-surgical endodontics
- It slows down the procedure, each procedure takes more time
- Four or six handed dentistry is mandatory
- Learning takes time
- Cost of the microscope and accessories
- The normal instruments are too bulky, hence smaller sized instruments are required

Improved and ideal treatment ergonomics

- All stooping and bending is eliminated
- Constant bending collapses the diaphragm

The law of ergonomics

Class I motion: moving only the fingers

Class II motion: moving only the fingers and wrists

Class III motion: movement originating from the elbow

Class IV motion: movement originating from the shoulder

Operator positioning

- At the 11- or 12-o’clock position
- 9-o’clock position comfortable when first learning to use an DOM
- The operator must sit with his thighs parllel to the floor with the hips slightly elevated, feet planted firmly on the ground, shoulders erect and straight and perpendicular to the floor and arms stretched forwards with the elbows close to the body.
- The patient is moved to accommodate this position.

- Once the ideal position is established lower magnifications to locate the working area

The image is focused and stepped up to higher magnifications if desired.

Positioning of the OM and focusing

- Knowing the focal length of the objective lens, the operator moves the microscope up and down until the working area comes into focus.

Fine positioning of the patient

- Little movements can be done for the definitive position of the patient.
- Maxillary teeth - horizontal
- Mandibular teeth - trendelenberg position

Parfocal adjustment

- The focused view of the working area will stay sharp as the magnification is changed.
- It is mandatory that working area in focus to the operator, it is also in same focus to the assistant, for the video camera.

Use of Dental Operating Microscope

1. Diagnosis

a) Diagnosis of caries- magnification helps in identification of incipient carious lesion which is not visible to the naked eye

b) Soft tissue evaluation- this may not require magnification, however, at times, inconspicuous sinus tract can be located using higher magnification

c) Identification of cracks- definite enamel cracks can be detected under magnification

- Non-surgical procedures-

a) identification of anatomical landmarks- the anatomy of pulp chamber and the anatomical landmarks in the pulp are best viewed under microscopes. Microscopes help in better treatment of the pulp floors which avoid subsequent complications.

b) location of canal orifices- magnified views under the microscope make it easier to recognize the dentin coverage over the orifice, which can be removed precisely with an ultrasonic instrument

c)identification of cracks and fractures

d) removal of pulp tissue completely

e) identification of extra canals

f) ease in retreatment

Figure 2

Microscopic view of tooth

- Surgical endodontics
- The operating microscope has improved the visualization of surgical field. The operator can understand the root and tooth anatomy better and understand the reasons of errors during surgical procedures.
- The magnification, illumination and microinstruments constitute a microsurgical field.
- A resected root under higher magnification easily reveals anatomical details, such as isthmus, canal fins and lateral canals. The ultrasonic instruments help in preparing the root end in a precise manner.

Use of ultrasonics in combination with microscopes

- The advantages are: ultrasonic tips are more effective to “move” the coronal shaping away from furcations , flutings, and other high risk anatomical sites.

- Microscopic visualization is improved
- The mb2 or calcified chambers in posterior teeth rely on a lateral , not apical,motion that benefits from the micro-ultrasonic combination
- The cleaning and shaping can be better visualized rather than just relying on the “feel”

Endoscope

- The term endoscopy is derived from the Greek language and is literally translated as endon (within) and skopion (to see), hence the meaning, “to see within.” Early endoscopists such as Hippocrates in 377 BC used primitive tube-like instruments for endoscopy
- With major advances in the field of medicine, a breakthrough in optical quality was achieved in 1960 by an English physician, Hopkins, who created a rod lens series that led to important advancements in the field of view, magnification, and focal length of the endoscope, resulting in a clearer image.
- The field of endoscopy has expanded further with the introduction of the dental endoscope.
- The use of rod-lens endoscope in endodontics was first reported in literature in 1979.
- It was helpful in diagnosing dental fractures.

The traditional endoscope used in medical procedures consists of rigid glass rods and can be used in apical surgery and non-surgical endodontics.

- The flexible and semi-flexible endoscopes can be very valuable addition to the armamentarium. The endoscope is flexible due to special nitinol coating .
- The rod-lens endoscope provides clinicians greater magnification, greater clarity as compared to the microscopes and the loupes and the non-fixed field of vision. Non fixed field of vision is the ability to view treatment field at various angles and distances without losing depth of field and focus.
- The Modular endoscope system (Sialotechnology Ltd., Ashkelon, Israel) being based on modern technology of microendoscopes is used in small channel organs (salivary gland ductal system, tear canals) and is designed to enable the practitioner to work inside the root canal with magnification and instrument access.

The system includes three parts: endoscopic compact system, optical part that includes ocular part and the endoscope and handpiece with a disposable part.

Uses of dental endoscope

- Diagnosis: The dental endoscope viewing system (Dental View) is currently available as a diagnostic and therapeutic adjunct to the restorative dentist, endodontist, periodontist, oral pathologist, oral surgeon, otolaryngologist, and dental hygienist.
- Enhances Visualization: This dental endoscopic viewing system provides high magnification (24X to 50X) and a light source via a fiber-optic illumination that allows to detect new carious lesion, recurrent caries, inadequate restorations in proximal boxes or class V restorations, intrafurcal fractures, anatomic aberrations, (eg, a palatal groove on maxillary lateral incisors), residual crown and bridge cement, oral pathologic lesions, and root fractures/perforations.
- Transillumination: In cases of tooth infraction, the endoscope can provide transillumination as a diagnostic aid. As a fiberoptic light source, it is an excellent tool for fracture detection as light may refract along fracture line.
- Apical Surgery: The surgical procedure is performed under the inspection of the endoscope with intermittent irrigation of isotonic saline and suction. The curvature of the hand-piece enables the practitioner to visualize the hidden parts of the cavity

preparation, and to inspect for cracks and root fractures in the apical retrograde preparation.

- Endoscopic Observations during Endodontic Treatment The endoscopic observation and treatment usually leads to detection and removal of the remaining dental pulp tissue following cleaning and shaping of the root canal walls .Lateral canals and microscopic root cracks are usually detected with high accuracy, providing better intraoperative judgment and facilitating adequate treatment.

Orascope

- The recently introduced flexible fiberoptic orascope is recommended for intracanal visualization, has a .8mm tip diameter, 0º lens, and a working portion that is 15mm in length. The term orascopy describes the use of either the rigid rod-lens endoscope or the flexible orascope in the oral cavity. (8) Orascopic endodontics is the use of orascopy for visualization in conventional and surgical endodontic treatment. (17)
- The difference between an endoscope and an orascope is that:
- · an orascope is made of fibre-optics (Figure.5) and
- · an endoscope is made up of glass rods. (Figure.6)
- Both an orascope and an endoscope works in conjunction with a camera, light source and a monitor.

Endodontic Visualization System

The recently introduced Endodontic Visualization System (EVS) (JEDMED Instrument Company, St Louis, MO, USA) incorporates both endoscopy and orascopy into one unit. The EVS system allows for two methods of documentation. The camera head used in the EVS system is an S-video camera and, as such, documentation is usually accomplished by recording streaming video onto tape or digitized to DVD

- Now days the EVS II System is introduced. It also combines the fiber optic orascope and a rigid endoscope. It is said to provide optimal illumination and magnification for visualization during endodontic procedures. The system is designed to provide comfort and high quality images, and using it is said to require the same hand-eye coordination and patient positioning for ordinary procedures. The quick-connect camera handpieces can be efficiently switched to meet the needs of the procedure being performed.

Conclusion

- The operating microscope has revolutionized the speciality of endodontics. Surgical loupes have a fixed magnification which may not allow a proper visualisation in all surgical steps.
- Technological advancements in fiber-optic orascopes and rod-lens endoscopes have allowed for the development and evolution of these devices for use in clinical endodontics. The use of orascopy in conventional and surgical endodontic treatment has enabled clinicians to provide patients with improved and more predictable care.In the end, the excellent visual information can help the doctor to create more precise, more healthful, and more esthetically pleasing dentistry.

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