Magnification in Endodontics – A Review

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Abstract

The need for better visualization in the field of endodontics has been an ongoing challenge, the unaided vision is inadequate. In most instances to properly evaluate the endodontic procedure being performed enhanced illumination and magnification as adjuncts for posterior surgery is used. The introduction of aids to enhance vision in endodontics is performed and researchers found that they paralleled those of many medical specialties. The combination of improved lighting and magnification has been provided by several means like fiber optic headlamps and loupes, the surgical operating microscope, and most recently the orascope. This review puts a light on the armamentarium used for magnifications in endodontics since ages.

Keywords: Magnification, Endodontics.

Introduction

Nylen, at the University of Stockholm, was the first to develop a monocular microscope for otolaryngological surgery in 1922. By 1953, the Carl Zeises company (West Germany, which led to increased use in the medical field, particularly that of ophthalmology. In 1978, Apotheker developed the first device, the dentiscope, commercially available for dental surgery. The use of rod-lens endoscope was first reported in literature in 1979, used to aid in the diagnosis of tooth fracture. In 1996, it was described for use in surgical and non-surgical procedures for visualization. It was recommended to use an endoscope that was 6cm in length and had a 4.00mm diameter lens with a 30º angle for surgical endodontics. Since this time, technological advancements have enabled the development of similar endoscopes with increased angulations.(1)

Use of Orascopy

Orascopy is a procedure which uses an orascope or rodlens endoscope for visualization. To differentiate, an orascope is made up of glass rods. Both work in conjunction with a camera, light source (tungsten halogen / xenon lamp) and monitor. The option of a printer or digital recorder may be added to the system for documentation of a case or procedure.(2)

Rod – lens endoscope

The use of rod – lens endoscope was first reported in the literature in 1974, (Detsch et al) used to aid in the diagnosis of tooth fractures, in 1996, it was described fro use in surgical and nonsurgical procedures for visualization. The early endoscopes were large and somewhat cumbersome, and certain angulations, (beyond 30º) produced a fish-eye image. Recent advances have produced scopes with smaller lens diameters, ability to use 70 and 30-degree angulations, and no fish-eye effect. It allows clinician greater (magnification) clarity comparable to the microscope or loupes, and a non-fixed field of vision. The latter offers the ability to view a treatment field at various angles and distances without losing depth of field and focus. This is a major advantage over the use of microscope for endodontic treatment visualization.(2)

Fiber optic Orascope

Limited intracanal visualization was the catalyst for fiberoptic development. Ten years ago, fiberoptic imaging was ergonomic yet suffered from poor imaging quality. Today a unique lens design combined with a digital image processing system in the camera allows fiberoptics to obtain excellent intra and extracanal visualization. Fiberoptics are made of glass or plastics and therefore are small, light in weight, and very flexible. Image quality and No. of fibers a size of the lens used. Currently, there exist two diameter sizes of flexible fiberoptic probes used in endodontics: the 1.8mm and the 0.7mm. The 1.8mm probe consists of 30,000 parallel visual fibers and the 0.7mm probe has 10,000 parallel fibers. 0º lens a working portion of 15mm. each visual fiber is between 3.7um and 5.0um in diameter. A ring of much larger light transmitting fibers surrounds the visual fibers for illumination of the treatment field.(3)

General orascopic visualization technique

Unlike using loupes or a microscope, orascopy are in much closer proximity to the field by treatment. Factors such as blood, discharge, or condensation (produced on the probe lens due to a difference in the temperature between the operatory and the mouth) affect the clarity of the image. Placing an antifogging solution can prevent this condensation. Orascopy is used when a high magnification with a good depth of field for critical evaluation of a treatment area is required. The clinician holds the orascope or endoscope during examination or treatment (because is maintains a good eye-hand co –ordination). The operator or assistant may view the image on a monitor. The camera has digital zoom, which allows enhanced magnification of treatment field.[3]

Orascope use during conventional endodontics

Once the pulp chamber is cleaned of soft tissue, the 4mm lens diameter, 30 degree endoscope may be used to have a higher magnification to the floor of the access cavity. This is useful for locating additional holding orifices and verifying tissue removal. Instead of holding a mirror, the operator holds the endoscope, which may be stabilized by resting it on a cusp tip. The 0.7mm orascope is used to visualize the canal system. To accommodate its placement, the canal must be enlarged to size 90 in the coronal 15mm. if the canal is not widened sufficiently, a wedging of the probe may damage some of the fiber bundles within the scope. The focus and depth of the field is from zero to infinity, allowing for imaging of apical third without having been placed into this region of the canal. The canal must be dry at this point. Although the scope will see through sodium hypochlorite, this solution has a high refractive index, which causes significant reflected light to prevent a readable image.[4]

Orascopic use in surgical endodontic treatment

The 2.7mm diameter lens, 70 degree, 3cm length and 4.0mm diameter lens, 30 degree, 4cm length rod lens endoscopes are recommended for endodontic surgery. Because warm blood will create lens condensation, homeostasis of the surgical site must be obtained before use. The scope should be stabilized on the bone so that the operator gets a clear view of the root-end, adjacent teeth, depth of the tissue within a lesion, etc. the 70º angle enables the scope to provide imaging of resected root end. The 1.8mm fiber optic probe is used to visualize both conventional and surgical sites.[4]

Microscope

It is a mirror imaging technology developed by MIRAS; mirror imaging solutions, it is a miniature-imaging tool embedded inside a dental mirror with an independent light source feature. The platform can accommodate interchangeable optic tools required for various clinical procedures. The various features include an advanced high-resolution magnification system with 30x max magnification, a revolutionary, digital, dental mirror with embedded video imaging device, powerful LED light source affixed to the edge of the mirror, exchangeable mirror lens to maintain infection control regime, minimum sterilization procedures with microscope's disposable course, water resistant. The optics used in the system incorporate the following features: Composition – glass prism and lenses, Design – image is captured through 102mm diameter transparent hole, focusing range – 4 to 40mm.[5]

Surgical operating microscope

One of the most important developments in surgical endodontics is the introduction of surgical operating microscope. Areas where surgical microscope can have great impact and consequence in clinical practice include: 1. Visualization of surgical field, 2. Evaluation of surgical technique, 3. Use of fewer radiographs because the surgeon can inspect the apex or apices directly, 4. Patient education through video, 5. Reports to referring dentists and insurance companies, 6. Documentation for dental legal procedures, 7. Video libraries for teaching programs, 8. Less occupational stress.[5]

Working of the surgical operating microscope

To appreciate what a surgical operating microscope can do, it is important to understand how it works. The four areas to be discussed are: 1. Magnification, 2. Illumination, 3. Accessories, 4. Documentation.

1. **Magnification:** The microscope offers rapid latitude in magnification ranges. The most useful overall magnification range is x3 to x30. The low magnifications (x3 to x8) produce a wider field of view (and high focal depth; this keeps the field in focus in spite of moderate movements. This range is therefore useful for orientation within the surgical field or for alignment of instrument tips. The midrange magnifications (x10 to x16) provide moderate focal depth. In endodontics these are the "working" magnifications; they provide reasonably large magnifications for all surgical procedures and a moderately deep field, which keeps the field in focus despite small movements. The high magnifications (x20 to x30) are use only for inspection of fine detail, such as resected root surface. The local depth is shallow, and the field moves out of focus with even slight movements. Experience suggests that magnification above x30 is of little value in periapical surgery because the slightest movement by the patient, sometimes even simple breathing throws the field out of view and out of focus.[6]

Eyepieces: Eyepieces play an important role in magnification. They are generally available in powers of x 6.3, x10, x12.5, x16 and x20.Binoculars: The function of binoculars is to hold the eyepieces. They project an intermediate image into the focal plane of the eyepieces. The interpupillary distance is set by adjusting the distance between two binocular tubes. Binoculars often come in different focal lengths. It is important to remember that the longer the focal length, the greater the magnification and the narrower the field of view. Binoculars are available with straight, inclined or inclinable tubes are parallel to the head of the microscope. Inclined binoculars are oriented so that the tubes are offset at 45 degrees to the head of the microscope. Inclinable tubes are adjustable between the straight tube and slightly beyond the inclined tube positions sometimes up to and sometimes beyond 90 degrees these are most useful for endodontic surgery. Magnification changers are located in the head of the microscope and are available as three-or five-step manual/changers or power zoom changers. Power zoom changers avoid the momentary visual disruption or jump common to three-or five-step manual changers. The surgical microscope is focused much like a laboratory microscope. The manual-focusing knob changes the distance between the microscope and the surgical field. The focal length of the objective lens determines the distance between the lens and the surgical field. A variety of objective lenses are available with focal lengths ranging from 100 to 400mm. a 175mm lens focuses at about 7 inches, a 200mm lens at about 8 inches, and a 400-mm lens at about 16 inches. The 200mm objective lens is recommended for endodontic microsurgery because this distance provides adequate room between the surgical field and the objective lens for surgical instruments and constitutes a comfortable working distance. An optimum configurations for endodontic microsurgery should have: X12.5 eyepiece, 200-or 250mm objective lens, 180 degree inclinable binoculars, a five – step magnification changer.[7]

2. **Illumination:** One illumination system consists of a 100-watt xenon halogen light source. The light is reflected through a condensing lens to a series of prisms and then through the objective lens to the surgical field. After the light reaches the surgical field, it is reflected back through the objective lens, through the magnification changer lenses, and through the binoculars, and then exits to the eyes as two separate beams of light. The separation of the light beams produces the stereoscopic effect that allows the clinician to see the depth of the field. Another illumination system is the fiberoptic system, however, a fan-cooled xenon halogen light system is recommended because fiber optic cables absorb light and have a tendency to be light deficient. Illumination is coaxial with the line of sight. This means that the light is focused between the eyepieces in such a fashion that the clinician can look into the surgical site without seeing any shadows. A beam splitter can be inserted in the pathway of light as it returns to the operator's eyes. Its function is to supply light to an accessory such as a camera or an auxiliary observation tube. Half of the light is always available for the operator.[7]
3. **Accessories:** Pistol grip or bicycle-style handles can be attached to the bottom of the microscope to facilitate movement of the microscope during surgery. Photographic and video adaptors are available to attach video cameras to the beam splitter.[6]

Uses of dental operating microscope

Access is enhanced by the use of a microscope, in which subtle color changes in the floor of the pulp chamber aid the operator in finding the openings to sclerosed canals. The shape the preparation in the coronal part of each root canal can be examined and progress monitored easily. It is only by examining the root canal with microscope that it is possible to determine that the canal has been dried sufficiently, prior to placement of an intracanal medicament / obturation. Examination under magnification ensures that air voids are kept to a minimum during placement of an intracanal medicament. The distribution of sealer in the root canal coronal to any curve can be verified with the microscope at 16 x or 26 x magnification. Provides a check to ensure that all traces of calcium hydroxide are removed from the root canal prior to obturation. Removal of retentive posts and perforation repairs are now performed more easily with increased visualization and illumination.[6,7]

Disadvantages of dental operating microscope

As the central object in the treatment field becomes more magnified, the perimeter of the field of view becomes out of focus, and the overall depth of the field becomes limited therefore, at high magnification, any movement of the microscope or the patient will cause the treatment field to become out of focus. It must remain in what is referred to as a fixed field of vision. Preparation of the root canal system is less easy to carry out using the microscope, whether hand or mechanical instrumentation. When any instrument is placed within the root canal, the operator's view of the canal is blocked. In addition, where it is possible to place a dental mirror to view the movement of the instrument within the root canal, the image on the mirror head is often difficult to focus through the microscope. The microscope however may be an aid in the initial placement of the instrument into the root canal orifice. Finding and treating the fourth canal, in maxillary first and second molars is greatly enhanced. Allows for a more conservative approach in surgical root-end treatment. Magnification in combination with the newly developed micro-instruments has enabled us to prepare and place materials into very small areas.[8]

Indications for use of DOM in surgical cases

Small mandibular anterior teeth, after containing two canals. Bicuspids where root outlines are irregular near the apex so that better visualization aids in determining the presence of one, two more portals of exit. Root amputations to ensure that the portion left after resecting the root is clearly seen and prepared smoothly, eliminating plaque traps. Magnifications used in surgical endodontics. For reflecting a flap or suturing – 2 X.

Osteotomy – 2.5 X to 6 X. Examination of the stained root, surface for the presence of the periodontal ligament – 10X to 12 X. Micro inspection of the resected root surface (isthmuses, C-shaped canals, apical micro fractures, accessory canals) – 16X to 25X. Ultrasonic root – end preparation – 9X to 16 X. Retro filling – 10X.[9]

Surgical telescopes or loupes

Most dentists have clinical experience with conventional surgical telescopes or loupes and surgical headlamps. Telescopes or loupes are commonly available in a variety of configurations and magnification. Where a fiber-optic headlamp is added to the armamentarium, white light is projected co-axially with the line of sight into the surgical field, and both surgical and non-surgical procedures can be performed with lees eye strain and fatigue. These telescopes or loupes provide magnification ranging from x2 to x6 it is recommended to use x2-2.5 loupes for visualization prior to the use of orascope / endoscope. Loupes should be used in the conventional endodontics to access canals and in surgical endodontics to reflect gingival, remove cortical and medullary bone and isolate the root end. However, the problem with the magnification instruments attached to the head is that even moderate movements of the head result in total visual dislocation and the loss of visual field, especially at higher magnification. Efficient use of these visual aids requires a steady head and only incremental movement, a difficult habit to acquire.[8,9]

Conclusion

In spite of their significant cast and the relatively long learning curve associated with their use, various magnification aids assist in producing high quality dentistry seeing better also means decreasing operating time and increasing clinical confidence. A strong consideration should therefore be given to adopting this concept.

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