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RESEARCH ARTICLE

REVEALING THE UNSEEN - A REVIEW ON OPERATING MICROSCOPE.

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Abstract

From many decades various newer advancements in dentistry have been introduced to attain successful outcome of treatment. The biggest upheaval in the field of dentistry can be credited by the commencement of operating microscope. High magnification and illumination attributes an endodontist for exact diagnosis, aiding in locating missed canals or extra canals, assessing the usage of newer systems during instrumentation, retrieval of fractured instruments and also to inhibit the occurrence of procedural errors which is obtained by using operating microscope. Operating microscope has totally changed the route of endodontics from the field of blind dentistry to a successful era with better viewing enhancing successful treatment therapy. The following article summarizes the parts and uses of microscope, position of operator, position of patient.

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Introduction:-

Operating microscopes have been used for decades in many of the medical disciplines; ophthalmology, neurosurgery, reconstructive surgery, otorhinolaryngology, vascular surgery.^[1] Its commencement in dentistry in last fifteen years particularly in endodontics has led to an upheaval on how endodontics has been practiced worldwide. Telescopes or loupes have been readily available in various configurations and magnifications. Light can be projected in the line of vision to create shadows and increase the aid for better viewing the treatment area.^[2]

The preface of the operating microscope has altered both non-surgical and surgical endodontics. Every challenge existing in the straight portion of the root canal system that is in non-surgical endodontics including the most apical part, can be seen precisely and can be managed skillfully under the microscope. It is possible to cautiously examine the apical segment of the root-end in surgical endodontics. The surgical operating microscope has been recently popularised in endodontics where increased magnification and illumination have resulted in improved technical accuracy and performances.^[3]

Limits of human vision:-

Carr et al reported that the resolving power of the unaided human eye is only 200 microns or 0.2mm apart.^[4] Webster et al has defined resolution as the ability of an optical system to make clear and differentiate into two separate entities. Hence most people who view two points closer than 0.2 mm will see only one point.^[5] The optical

aids such as loupes, microscopes, surgical headlamps, fiber optic handpiece lights, etc. are used to improve resolution by many orders of magnitude.

Parts of surgical operating microscopes:-^[6,7,1]

The operating microscope consists of three primary components; the supporting structures, the body of the microscope, and the light source.

Supporting structure:-

It is necessary that the microscope must be stable while in operation and remain portable with ease and accuracy particularly when used at high power. Mounting of the supporting structure can be on the wall, floor or ceiling. The stability of the set up is increased, as the distance between point of fixation and the figure of the microscope is reduced. In clinical settings with high ceilings or distant walls, the floor mount is more preferable. The tightening of the built-in springs should be done according to the weight of the body of the microscope to achieve a perfect balance in any position. This permits accurate visualization perceiving fine focus.

The body of microscope:-

Lenses and prisms are present in the body of microscope making it responsible for magnification and stereopsis. Eyepieces, binoculars, magnification changer factor, and the objective lens is comprised in the body of the microscope. Eyepieces are that are commonly used are 10x and 12.5x. Eyepieces also have adjustable diopter settings. Diopter setting is of significance importance when an assistant scope and documentation equipment are used, for uniform focussing (par focalled).

The binoculars contain the eyepieces which allow the adjustment of the interpupillary distance with the focal length of 125 or 160 mm. Manual alignment is done or with the aid of a small knob the alignment is done until the two divergent circles of light combine to highlight a single focus. Once the adjustments of diopter setting and interpupillary distance have been made, they should not have to be changed. Binoculars are available with straight, inclined, or inclinable tubes.

Magnification changers are available as 3-, 5-, or 6-step manual changers, or a power-zoom changer that are present within the head of the microscope.^[6] The magnification is altered by rotating the dial. Focusing with a power zoom microscope is performed in the head of the microscope by a foot control. The advantage of the changers in power zoom is that the momentary visual disruption is avoided or jump that occurs with manual step changers as the clinician rotates the turret and progresses up or down in magnification. The variation of focal length can range from 100 mm to 400 mm. In endodontics, a 200 mm focal length allows approximately 20 cm (8 inches) of distance from working area. This permits precise visualization and renders fine focus.^[2]

Combination of the four variables allows the total magnification (TM) of a microscope depending on the:

- 1) Focal length of binocular (FLB);
- 2) Focal length of objective lens (FLOL);
- 3) Eyepiece power (EP)
- 4) magnification factor of the changer (MF).

The typical microscope can be characterized by the following formula:

$$TM = (FLB/FLOL) \times EP \times MF$$

For example: Binocular focal length = 125mm

Objective lens focal length = 250 mm

Eyepiece magnification = 10x

Magnification factor = 0.5

$$TOTAL\ MAGNIFICATION = 125/250 \times 10 \times 0.5 = 2.5x.$$

Light source:-

One of the most important features of microscope is light source which is powered by 100 to 150 watt halogen light bulb connected to the microscope having a high efficiency of fibreoptic cable. Through a condensing lens light is passed, forming a series of prisms which passes through the objective lens to surgical site. The intensity of light is controlled by the rheostat.

Loupes:-

Magnifying loupes were introduced to produce magnification which are classified by the optical method. There are three types of binocular magnifying loupes: (1) a diopter, flat-plane, single-lens loupe, (2) a surgical telescope with a Galileian system configuration (two lens system), (3) a surgical telescope with a Keplarian system configuration (prism roof design that folds the path of light).

Positioning of microscope:-

The clinician, patient, and assistant should have proper positioning. Most problems in a clinical setting having a microscope are related either to positioning errors or lack of ergonomic skills on the part of the clinician.^[8]

1) Operator positioning:-

Behind the patient at the 11 or 12 o'clock position is the correct operator position for nearly all endodontic procedures. Positions other than the 11 or 12 o'clock (for example 9 o'clock) may seem more comfortable when first learning to use a microscope. The operator should adjust the seating position so that the hips are 90 degrees to the floor, the knees are 90 degrees to the hips and the forearms are 90 degrees to the upper arms. The operator's forearms should lie comfortably on the armrest of the operator's chair and his or her feet should be placed flat on the floor. Regardless of the arch or quadrant being worked on, the back of clinician should be in a neutral position, perpendicular and erect to the floor. The patient has to be positioned correctly with chairs adjusted such that the arm rests of the doctor's and assistant's are comfortably placed at the level of the patient's oral cavity. The trapezius, sternocleidomastoid, and erector spinae muscles of the neck and back are completely at rest in this position.^[8] This relieves the clinician from complete fatigueness and provides compatibility with the operating microscope in the treatment of patient.

2) Positioning of the patient:-

The placement of the patient should be in the trendelenberg position and the chair is raised until the patient is in focus. The focal length of the microscope can be optically changed simple by activating the zoom control such that the patient's height can be varied to fit the most comfortable position. This ability to easily change the focal length of the lens makes patient positioning to the ideal height possible on nearly all patients. Now it is necessary to make little movements with the back of the dental chair, in order to position the patient in the definitive position. With this in mind, one should take into consideration that in nonsurgical endodontics 100% of the work at the microscope is done in indirect vision through the mirror. Therefore, the definitive position of the patient depends on the angle that the light of the microscope has to make in order to illuminate the root canal where the clinician is working. The root canal of the tooth to be treated must be positioned at 90° to the light beam, while the mirror is at 45° angle. Therefore, to work in a maxillary root canal the patient should be horizontal, parallel to the floor to work in mandibular root canal the patient should be in "Trendelenburg" position, which means with the head slightly lowered to the pelvis.^[9]

3) Positioning of the microscope and fine focus:-

Portability of the microscope should be such that the circle of light shines on the working area when the light is turned on. The operator approaches the working distance by moving the body of the microscope. The microscope is moved up and down until the working area comes into focus on knowing the focal length of the objective lens followed by looking through the eyepiece. During this procedure, the fine focus device of the objective lens should be in an intermediate position in order to allow a wide range (20 mm) during the fine focusing of the operative field. The inclinable eyepiece is now adjusted such that the head and spine of the operator can maintain a comfortable position with the working area in focus.^[10]

4) Adjustment of the interpupillary distance:-

Looking through the binocular, a small circle of light is seen through the naked eye. The interpupillary distance is adjusted by taking the two halves of the binocular head of the microscope and moving them apart and then together, until the two circles are combined and only one illuminated circle is seen. With some microscopes, this is made portable by moving a knob located on the binocular. Adjustable rubber cups extend from the ends of the eyepieces.

5) Parfocal adjustment:-

These are the steps to follow for the parfocal adjustment:

1. Position the microscope above a flat, stationary surface.
2. Using a pen or pencil, make an "X" on a piece of white paper to serve as a focus target and place it within the illumination field of the microscope.
3. Set both the eyepiece diopter settings to "0".

Also set assistant's eyepieces (if any) to "0".

1. Set the microscope near the middle of its focus range.
2. Position the microscope vertically at a convenient view height and so that the target is within the view range.
3. The highest magnification setting (zoom in) is done on the microscope and the fine-focus control is achieved by using fine focus until a sharp image is obtained.
4. Being careful not to physically shift the microscope position, change the magnification setting to its lowest position (zoom out). Focus left and right eyepieces, one at a time, by turning the diopter ring until the image is sharp and clear. The diopter is tightened by lock button to lock in this position, and record the setting for future use.
5. Each operator will have their own particular settings that are to be dialed in whenever that particular operator uses the microscope.
6. This procedure does not have to be repeated by the same operator each time the microscope is used. However, due to changes in eye correction associated with time, it is recommended that this procedure be repeated by the operator once or twice per year.

6) Fine focus adjustment:-

The fine focus changes the focused area from one plane to another dipper inside the root canal, is made lifting just a few millimeters the entire back of the dental chair with the operator's knee .

7) Assistant scope adjustment:-

On completion of all the above mentioned procedures by the clinician, the dental assistant will perform the same adjustments on the binocular and on the eyepieces without changing the position of the microscope. Usually, the adjustment 4, 6 and 7 are made only once, while the others are made each time the operator starts a new endodontic procedure.

Added benefit of dental microscope in endodontics:-**Diagnosis:-**

Detection of fracture and cracks along with the evaluation of marginal integrity of restorations is enabled by an endodontist using an operating microscope. "Cracked tooth syndrome" is seen when the crack is coronal or it may be found after the restoration is removed. Once the tooth has been assessed, cracks can also be identified on the floor of the pulp chamber. Dyes like methylene blue or a caries detector can aid to better determine the crack and to follow its length to its termination. It is also useful to identify radicular cracks and fractures. In many circumstances, the width of the crack is merely that of a hairline and would remain unidentified without the use of operating microscope^[11,12]

Locating canal orifices:-

Important visual phases of endodontic therapy is to analyze the pulp chamber and locating the canal orifices. The operating microscope has proven to be indispensable for the localization of coronally obstructed canals. The practitioner is brought into the pulp chamber floor, with high intensity light revealing in intimate detail of the area with the guidance of microscope.^[10] Practitioners can proceed with confidence and skill because they can see subtle and minute differences in color. Calcification patterns become immediately obvious, serving as a road map in removing the obstructions. Hidden canals can be located easily and the chances of missing canals is reduced. Small instruments are used under the microscope to localize the canal orifices, like the JW-17 (C K Dental Specialties) or the Micro Opener (Densply Maillefer) .

Retreatment:- Usage of microscope during retreatment is a biggest advantage of microscope. With the use of the operating microscope every challenge existing in the straight portion of the root canal ,including the apical part can be easily seen and resolved.

Removing fractured instruments:-

Retrieval of broken instrument by using the operating microscope and a specially designed ultrasonic unit and tips, is one of the biggest advantage of operating microscope. The instrument is visualized using high magnification. Then a specialized ultrasonic tip is energized, creating a trough around the coronal 2mm of the instrument. The clinician has commanding visual control at all times during this procedure, resulting in minimal loss of root dentin. The instrument is agitated with the side of the tip after the troughing procedure. Since it has a tapered shape it will begin to spin and move coronally, which can then be retrieved using microsurgical forceps that can be manipulated in the pulp chamber because of their small size.^[13,14]

Repairing of perforations:-

The demonstration in locating perforations can be easily obtained using operating microscope allowing for more efficient management of this complication through a specific and precise intra-canal access which can be accomplished only with the aid of enhanced vision and illumination from a high powered microscope.

Surgical endodontics:-

Of all the areas in endodontics, surgical endodontics has perhaps benefited most by the commencement of operating microscope. The operating microscope enhances surgical skill in both hard tissue and soft tissue management. Levels of illumination and magnification that are suitable for surgical endodontics is achieved by using operating microscope.^[4,5]

Root-end procedures:-

Endodontists performing surgical procedures have always been true microsurgical procedures even though the microscope has been recently introduced. Evaluation, preparation and filling of the root apex are true microsurgical procedures. The examination of the beveled root apex in minute detail has been done by introducing optical grade micromirrors. The ability to observe the beveled edge of the root at high magnification brings a whole new world of detailed anatomy of root into focus. The evaluation of poorly condensed gutta-percha leakage around sealer voids, eccentric and irregular canal shapes, uninstrumented isthmus areas, accessory canals and canal fins and circumferential resorption of prior retrofilling materials, helps the practitioner design and implement a corrective design to his retro-preparation. Because most roots sustain an exaggerated bevel at the time of their resection, the needed preparation must be broad buccal-lingually. Use of the smaller retro mirrors it is possible to cautiously examine the apical segment of the root end and perform an atraumatic, apical resection procedures and permit a coaxial ultrasonic preparation into the root, better management of the bone structures thereby making minimally invasive class I retrograde cavity preparation and retrograde filling of the canal system and all its branches along the longitudinal axis of the root easy to perform.^[2,15]

Using the surgical microscope and retromirrors, the bevel and sectioned roots can be modified more perpendicularly to the long axis of the root. Also the ability to inspect, prepare and seal the isthmus area between confluent canal systems can be precisely achieved.

The use of micro mirrors enables the clinician to look up into the apical preparation to check for completeness of tissue removal. Suturing can also be accomplished more precisely using the operating microscope (even though some magnification), allowing a more rapid healing.

Conclusion:-

Introducing an operating microscope into a dental office involves fine understanding of the importance of ergonomic practice. Fine acquaintance in the usage of operating microscope can lead to accurate performances in endodontic therapy reducing the occurrence of procedural errors in endodontic practice leading to a successful outcome of endodontic therapy.

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