Journal of Advanced Clinical & Research Insights (2021), 8, 87–90

REVIEW ARTICLE

A detailed review on ergonomics and parts of dental operating microscope

S. Sharmila[1], A. Lavanya[1], Ranjith Kumar[2]

[1]Department of Endodontics and Conservative Dentistry, Dr. Ziauddin Ahmad Dental College and Hospital, Aligarh Muslim University, Aligarh, Uttar Pradesh, India, [2]Department of Oral and Maxillofacial Surgery, Dr. Ziauddin Ahmed Dental College and Hospital, Aligarh Muslim University, Aligarh, Uttar Pradesh, India

Keywords:
Dental operating microscope, ergonomics, illumination, magnification

Correspondence:
Ranjith Kumar, Department of Oral and Maxillofacial Surgery, Dr. Ziauddin Ahmed Dental College and Hospital, Aligarh Muslim University, Aligarh, Uttar Pradesh, India.
E-mail: rkranjith.29@gmail.com

Received: 08 June 2021;
Accepted: 13 July 2021

doi: 10.15713/ins.jcri.338

Abstract

Advancements in endodontics in the past two decades have given endodontists important new tools to save natural dentition. These advances have enabled clinicians to complete procedures that were once considered impossible or that could be performed only by skilled clinicians. Until recently, endodontic therapy was performed using tactile sensitivity, and the only way to see inside the root canal system was to take a radiograph. Now, the scenario has been changed with the introduction of DOM which has been shown to enhance quality, longevity, and outcome of clinical work as well as facilitating better ergonomics for both the dentist and dental nurse. This paper explores parts of the operating microscope in general dental as well as specialist practice (such as endodontics), ergonomics and how the interested clinician can use such equipment in a practical manner.

Introduction

Operating microscopes are a novel innovation in the field of dentistry. The laboratory technicians and prosthodontists make use of different stereomicroscopes to check impressions, trimming dies, creating wax-ups, to fix, and to check the castings. Baumann,[1] Jako,[2] and Apotheker[3] suggested the use of surgical operation microscope in the field of dentistry.

Recently, Rubinstein,[4] Can,[5] Pecora and Andreana,[6] and Izawa *et al.*[7] employed SOM and microsurgical techniques in endodontic surgeries. The SOM has exceptional magnification power and illumination that makes the microsurgical techniques more precise and accurate. The use of microsurgical approach and periapical ultrasonic has opened its door to the inaccessible areas of the oral cavity thus making endodontic surgeries possible even in the most posterior regions of the oral cavity.

Dental Operating Microscope

Apothekar introduced the microscope in 1981. For the effective and successful outcome of microsurgery, dental operating microscopes have become vital part in visualizing the efficacy of disinfection, debridement, membrane, and scaffold placement, obturating root canals. As loupes are to be worn regularly on the physicians head, its external light attachment, weight has made it inferior to microscopes. When comparing to loupes, microscopes are self-supported units with LED illumination and also helps in maintaining upright position of the physician. As a result, additional lenses or prisms will not bother working efficiency of dentist which has major advantage in ergonomics and visualization. Depending on the physicians requirement and spacing available floor-standing unit or wall-mounted units can be preferred.[8]

The operating microscope has a digital camera attached to it that helps to visualize the operating field, clearly distinguish bone with root, examine fractures, and precisely remove the granulation tissue, apical preparation of the root canal, and retrograde obturation. These microscopes capture even the smallest of the operating field that aids in recording patient details, explaining the same and for further research studies.[9] In DOM, the light rays travelling toward the right and left eyes are parallel thus reduce the ocular muscle strain, fatigue comparative to loupes. Whereas in loupes, the direction of light rays are convergent causing eye strain.

Different magnification ranges are required for non-surgical and surgical endodontics.

It can be divided as follows:

- Low magnification (~×2–×8)

- Mid magnification (~×8–×16)
- High magnification (~×16–×25).[10]

Basic Components of Microscope

In the past, standard microscopes had fixed focal distance (200 mm, 250 mm, or 300 mm) based on height of practitioner and working position. Since then, these microscopes have undergone various advancements and alterations till date.[8]

The operating microscope basic components are as follows:

- Binoculars
- Microscope body with magnification and fine focus adjustments
- Light source.

Microscope Body

The body of microscope is made of three parts:

1. The upper segment has a dovetail receptacle with a knurled clamping screw to hold any accessories or binocular tubes
2. The middle segment has a magnification adjusting apparatus[8]
3. The lower segment has a threaded dovetail receptacle to view the object in front.

Binoculars

The use of similar principle of telescope in binocular tube setup allows stereoscopic viewing can be applied in field glasses. The lower threaded dovetail receptacle ensures the alignment of the binocular tubes in its optical axis with the body with the help of clamping screws.[11] Variable inclinable tubes are available in binoculars from 0 to 220° which will help to hold any head position. Interpupillary distance is adjusting the distance between the two-binocular tubes. The binocular tubes can be adjusted either inward or outward depending on the pupillary distance of the concerned person.

Beam Splitter

It is the primary part for the documentation accessories and other attachments. It is around 50 mm in depth which increases the overall length of microscope and is attached to microscope body like binocular tube system. There are two cube systems available in beam splitter. Advantage of these cubes is, when the rays travel in a parallel pathway, these cubes allow only a fraction of rays to pass through them whereas the remaining fraction is diverted from its original pathway at an angle above 90°. The light intensity of nearly 20% is converted to still photography or video camera by a beam splitter.[12]

Magnification Changer

Magnification changer has a manual changer (3, 5, or 6 steps) and zoom changer. The manual changer has a turret fixed lens with a dial seen on the side of the microscope. The first magnification factor is altered by adjusting the position of the dial.[11] The second magnification factor is produced by rotating the dial which reverses the lens position. A 5-step magnification changer compiles the eyepiece power, focal length from two pair of lens, and blank space in a lens less turret.

Zoom changer can be manual or power. The magnification factor in a manual zoom changer is adjusted by a sequence of lenses on a focusing ring that move back and forth, whereas power zoom changer is mechanical variant of the former added up with a foot control for hand-free magnification.[8] The main aim of zoom changers is to bypass the momentary optical break produced when rotating the turret up and down for magnification.

Magnification Powers Used in Endodontics

Magnification can be adjusted on the following three levels:

1. Low magnification (×3–×8)
   - This level is mainly used in loupes (straightforward cases)
   - For comparison with adjacent anatomic landmark
   - To examine the tooth orientation and position of ultrasonic tip or bur.[13,14]
2. Medium magnification (×8–×16)
   - Identify root canal orifice
   - To identify, prepare, fill, and resect the root tip
   - Obturation
   - Root surface analysis[8]
   - Fracture diagnosis
   - Hemostasis and removal of tissues.
3. High magnification (×16–×30)
   - Calcified canal orifice and for minute cracks
   - For the inspection of minute anatomies.

Light Source

Precisely of the vital aspect of DOM is the light source as they help for the illumination in the deepest portions of root canal. Light source should offer coaxial illumination. The light can enter the canal at any angle, but it should perfectly coaxial with operator's view, thereby avoiding the shadow.[9]

The light source in the first dental microscope was Halogen light. It was introduced for standard applications, displaying yellowish hue and it is not indicated for documentation. Xenon and LED lights having their own light intensity, wavelengths, chroma, temperature, heat discharge, and lifetime were introduced to provide desirable illumination in the operating area. Xenon light is the best illumination light for visualizing fine anatomical details, short exposure times which will give sharper images, it is almost like a natural daylight at 5000°Kelvin have highest intensity. LED light sources appear close to natural light and they are analogous to xenon in color and temperature. Depolarization and daylight UV filters are recent advancements for caries detection.[8]

Documentation

In the past, documentation was done in different ways. With the emergence of digital radiographs, unlimited clinical images are captured by a video camera present on the microscope's beam splitter and sent to the video card in the computer for documentation. These images are then saved and updated with the patient. A 30 s loop video of immediate past can also be recorded with resolution of HD ready 720p to full HD 1080p. Three chip cameras provide full HD 1080p with finest resolution documents that can be used for presentations and publications. Latest surge in the technology has brought chair side 3-D monitoring by both the operator and observer.[15]

Parfocaling

Microscopes are devised in a way it can be fine-tuned to diverse range of vision. After a tiring work day, when the ocular muscles are in fatigue state parfocaling results in a different reading comparative to that of the resting state. In this scenario, the work period has to be modified. This involves identification of the observer's dominant eye to accommodate the vision.

Out of various techniques, two techniques are described below to identify the dominant eye:

Superimposition technique

Hold a nearer object (ex., pencil) with arms extended in such a way the object superimposes a distant object (ex., street light). Now open one eye and close another eye. When the dominant eye is open, the pencil will be centered with the street light. When the non-dominant eye is open, the pencil moves sideway from the street light.

Paper technique

Make a hole in a paper and focus on the hole with both eyes opened. Now slowly bring the paper toward the eye. The dominant eye will focus on the hole the hole approaches the eyes.

Parfocaling is done with the corrective glasses, if necessary. The dominant eye receives the eyepiece reticle. A reticle is a set of fine lines that provide proper centering on the object in focus and allows for individual calibration (parfocaling) of the microscope, most commonly in the shape of cross-hairs or concentric rings.[15]

Ergonomics

It is essential to systematize the operatory ergonomically after installing the microscope. The vertical dimension of the clinician movements during surgery can be maintained by not moving his eyes and hands from the field to reach any instrument. First assistant should retain the suction under control so that bleeding does not hinder the visibility in non-surgical endodontics and left hand of the operator should hold the mouth mirror all the time and should orient light source to the teeth.

Ergonomic motion is classified as follows:

- Class I – movement of fingers only
- Class II – movement of fingers and wrists only
- Class III – movement arising from elbow
- Class IV – movement arising from shoulder
- Class V – movement involving twisting at the waist.[16]

Positioning of DOM

Major disadvantages of DOM are positioning errors or inadequate ergonomic skills of physician. There is always a need to properly monitor the ergonomics to work with as little muscle tension.

The chronologic order in which DOM prepared is as follows:

1. Operator's position
2. Patient's rough position
3. Position and focus of DOM
4. Interpupillary distance accommodation
5. Patient's fine position
6. Adjusting parfocal
7. Adjusting fine focus
8. Assistant scope adjustment.[16]

Conclusion

Nowadays, endodontic surgeons are able to render services with confidence and great precision with the help of microscope. The introduction of the operating microscope in endodontics represents a qualitative leap for the profession. Magnification and coaxial illumination have immensely improved the likelihood of saving the tooth both surgically and non-surgically. The factors which influence the outcome of treatment can be changed with the help of microscope. To use the microscope, surgeons must familiarize himself with it and also should train the assistant to work with it. In the beginning, it seems to be difficult for both dentist and assistant but in a short period of time, both will familiarize with DOM.[16] The advantages with microscope are good magnification and better illumination. High cost, increased surgical time, and time needed to train the assistant are the major disadvantages with microscope. Success rate is higher for surgeries done with DOM when comparing with traditional techniques.

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How to cite this article: Sharmila S, Lavanya A, Kumar R. A detailed review on ergonomics and parts of dental operating microscope. J Adv Clin Res Insights 2021;8(4): 87-90.