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Principle Conceptual Paper

Magnification in Endodontics: "Vision into Reality"

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You can only treat what you can see! — Prof. Syngcuk Kim [1].

Magnification beyond doubt brings us closer to reality. Dental operating microscopes today can be rightly accepted as one of the finest advancements of technology in dentistry. Interpreted as visualizing objects at an increased size than what is perceived by naked eyes, magnification ranges from as simple a tool as magnifying glasses to the most complex ones like surgical operating microscopes. Present era magnification is previewed as an indispensable tool in fields of medicine like ophthalmology, otolaryngology, neurosurgery, cardiac surgeries etc. Since its introduction into dentistry in the last twenty years especially in endodontics, the dental practice has greatly revolutionized but unfortunately its application remains slower than expected amongst dentists. A plethora of magnification aids ranging from magnifying glasses, magnifying loupes, optical microscopes, electron microscopes, endoscopes and orascopes to surgical operating microscopes have been tried till date. Restricting myself to clinical dentistry, most commonly used magnification tools in our field are dental loupes and surgical operating microscopes.

Dental loupes were amongst the earliest refined tools to provide an enlarged image of the working site. Often, when I used to see dentists working with dental loupes, I used to wonder as to how challenging would it be to work with this additional appendage sitting on the nose and deal with scratches and fogging. Soon I realized that my personal brush with this instrument and perseverance during this adventure enabled me to understand and overcome frustrations associated with its use, and deliver quality while maintaining ergonomic postures. These were the simplest and earliest magnification tools that made dentistry more real for me. Currently used loupes are more advanced, based on Galileian optics and are available in different configurations like with the sports frame, with the titanium frame, with the headband and through the lens type (TTL). Loupes progressed over generations ranging from simple to compound to prism with betterment each time, but still are associated with certain shortcomings like limited magnification of 2x to 6x, limited possibility of adjustment in working distance, limited field of view and depth of field, strained neck and back when used for longer durations and lack of ability to document. In an attempt to overcome these limitations, next advanced and highly attractive introduction in dentistry was seen in the form of Dental Operating Microscopes (DOM) which allowed dental procedures to be executed more accurately and predictably. Variable and adjustable magnification along with shadow free lighting were a few enhanced features offered by this equipment. Nonetheless, dental loupes cannot not be disregarded as they serve an important bridge in the steep learning curve for dental operating microscopes. They are ideal for getting acquainted to changes in hand eye coordination under magnified vision and are the most suitable economical magnification alternatives available for beginners. Also, they are quite useful in areas difficult to approach by microscopes.

Microscopy dates back to the invention of Janssen Compound lens microscope by Hans and Janssen (Dutch lens makers) in 1611 followed by Hookes microscope invented by Robert Hooke in 1665. Dr. Apotheker and Dr. Jako were pioneers in bringing the concept of extreme magnification into dentistry in 1978, in the form of an operating microscope [2]. The first Dental Operating Microscope called Dentiscope was introduced commercially in 1981 by Chayes-Virginia Inc, but did not gain much acceptance due to shortcomings like single magnification power (8x), poorly balanced arm, fixed focal length of 250mm and ergonomically poor design. Earlier literature showing use of microscope did not grab much attention until two eminent specialists Prof Syngcuk Kim (university of Pennsylvania, Philadelphia, USA) and Dr Gary Carr (San Diego, USA) facilitated the establishment and widespread use of microscopic techniques in endodontics in late 1880s [1,3,4]. In 1995, the American Association of Endodontists (AAE) formally recommended to the Commission on Dental Accreditation (CODA) of the American Dental Association (ADA) that training in microscopy should be included in the Advanced Specialty Education Programs in Endodontics. Finally, in January 1997, the accreditation bar was raised and microscopy training was made mandatory in Endodontic Speciality Programs in USA. In 1991, Dr Gary Carr, introduced a DOM that had Galilean optics and was ergonomically designed, allowing ease of use for nearly all endodontic and restorative procedures [3].

Evolution has also happened in DOMs, latest being Zumax OMS 2350 3D, Zeiss EXTARO 300, Zeiss OPMI PROErgo, variscope etc with highly advanced features. Zumax OMS 2350 3D provides integrated 3D technology, enabling teaching in third dimension of "Depth Perception". In almost every super speciality of dentistry, the understanding of depth is important and 3D facilitates it won-

derfully. Zeiss EXTARO 300 provides a breakthrough in visualisation modes that involves a unique combination of microscope fluorescence mode and magnification which enables caries detection as well as simpler tooth restoration workflow. Zeiss OPMI PROErgo offers additional feature of motorized/foot-controlled adjustment of focal length making working comfortable for longer hours. Additional Mechanical Optical Rotating Assembly (MORA) interface connects the binocular tube at a right angle to the body of the operating microscope permitting limited independent rotation around horizontal axis of the binocular tube thus enhancing ergonomics and allowing the operator to be seated at 12 o'clock position [5]. Varioscope is a lightweight miniature head-mounted operating microscope for surgical navigation featuring display of additional computer-generated sceneries. One of its greatest advantages is the mobility of operator head [6].

The need for magnification is growing exponentially in dentistry but magnification works well only in coalescence with illumination. Various light sources providing illumination in magnifying aids are halogen, xenon and LED light bulbs. The light source transmits light through a fiber optic cable in a surgical operating microscope compared to a dental loupe where it is externally attached as a headlight to the loupe. Coaxial illumination i.e. light entering into root canal without any deflection thus eliminating any shadow formation is an essential feature seen in most microscopes. Operator eye comfort is greatly enhanced in DOM when parallel viewing optics of the Galilean system with range of variable magnification is combined with coaxial fiber-optic illumination. Also, the clarity of object is improved and there is presence of stereoscopic vision due to which one retains three-dimensional vision and depth perception when looking through the operating microscope.

Other unparalleled advantages provided by DOM include inbuilt still and video camera as well as provision of external attachment for camera required for documentation, co-observer tubes allowing for additional viewing by a third assistant, magnification changer which provides a range of magnification and can magnify the object from 1.5 to 30 times. The minimum and medium magnifications are used during the procedure and higher magnifications fortify the inspection not achievable by naked eye. Most importantly, DOM enhances the ergonomics of the clinician considerably with provision of features like inclinable binocular tubes and motorized zooming in newer versions. When working with DOM, a certain working distance is essential which promotes posture maintenance and ergonomics. It is important to practise four or six handed dentistry when working on dental operating microscopes.

Magnification has widespread role in dentistry but restricting to endodontics, its relevance in this field is largely concerned with both diagnosis and management. Having redefined the concept of visualization, it has enormously aided in establishing a diagnosis and enhancing its accuracy. Few areas where it has proved highly beneficial is in the diagnosis of microfractures, longitudinal root fractures, fissure caries etc.

Treatment applications and quality are undoubtedly rendered superior under microscopes compared to conventional approach. The skill and expertise of the clinician is enhanced as it enforces the use of rubber dam, modifies movements of the clinician to be micro-movements and encourages use of micro-debriders, micro-openers and ultrasonic tips. Beginning from gaining entry into the canal up till obturation, it allows the clinician to respect and achieve theoretical ideals at all steps of endodontic treatment e.g. facilitating complete deroofing and exposure of the pulp chamber, providing straight line access to the apex, location of canal orifices especially anatomical variations, understanding canal configuration, observing calcifications and apical ramifications and final examination of the canal system prior to obturation especially in cases of open apices, resorbed teeth, root fractures etc. Defects or kinks in root canal instruments observed under high magnification can help reduce errors like instrument separation. DOM has undoubtedly improved predictability in complex cases like those with perforation or those requiring retrieval of broken instruments or gutta-percha, surgical endodontics like microsurgical apicoectomy and retrograde filling [4].

Like any other new equipment, learning and adapting to use of microscope is associated with hiccups. Learning is slower in its initial phase as it requires training of assistants in addition to understanding procedural sequences but if used on a regular basis, it can be easily mastered in a duration of few months. With awareness spreading regarding its potential advantages and with regular training workshops being conducted, it is not far that it will soon be adopted as an integral item in the dental clinic armamentarium across the world. In a bid to improve upon our own skills and practice, especially in this highly competitive and physically strenuous profession, the cost of microscope should not be a limitation.

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