# MAGNIFICATION IN DENTISTRY: LITERATURE REVIW


## ABSTRACT

Over the past few decades, technological advances in endodontics have taken quantum leaps from conventional hand files to rotary system and from direct vision to magnification. The clarity and details are achieved by magnification devices such as orascope, dental loupes, and dental operating microscope. The details are very clear and revealing so that the endodontists can achieve precision in diagnosis, treatment procedures, and final assessment of the procedure performed. Magnification technique is undergoing continuous advancements, allowing a better precision and quality standard. Microdentistry with its expanding possibility and increased clinical implication has now set a higher standard in patient care and in success rate of treatment procedures.


## Introduction

Dentistry is led by a movement in technological advances which help clinicians with adequate training to incorporate the finest skills and equipment in day-to-day practice, thus enhancing their existing skills and knowledge and delivering the most ideal outcomes with utmost precision. A necessary attribute in modern dentistry for clinical work is a high level of visual acuity, especially for near vision. A common way to achieve a better vision is to effectively magnify the area of interest. **Worschech CC et al.** said that improved lighting, coupled with magnification, provides a clear distinction between surfaces that may look similar in colour or texture under traditional working conditions. The clarity and details achieved with magnification are so vivid and revealing that the clinician will immediately recognize the potential for improved precision in both diagnostic and treatment procedures.[1]

Over the years, many magnification devices have been introduced as bridging tools between the naked eyes and the microscope. In fact, tools, such as an endoscope, magnifying glass, and intraoral camera, have largely been superseded by contemporary devices that seem to be more practical and convenient for application, such as loupes and dental operating microscopes. [2,3,4]

## History

**1975**Baumans article stressing the benefits of theuse of an operating microscope to dentists and its possible uses in endodontics was published.

**1981** A preliminary report by Apotheker was published which highlighted the various applications of a special dental microscope (Dentiscope) including endodontics and teaching.

**1983**Humes and Greaves reported various uses of the operating microscope in general dentistry.

**1984** Reuben and Apotheker tested the dental microscope (Dentiscope) in an apical surgery and recommended its further application in endodontics.

**1986** Pecora and Adreana also used a microscope during the performance of 50 apicoectomies and reported reduced incidence of post-operative.

**1989** Selden and Bethlehem reported the successful non-surgical treatment of calcified canals using microscopes.

**1992**Carradvocated the use of microscopes for different routine endodontic procedures.

**1995** Weller et al. stressed the use of surgical operating microscopes in recognizing and treatment of the canal isthmus during apical surgeries to increase the success rate.[2]

**Magnification** is the process of enlarging the apparent size, not the physical size, of something. This enlargement is quantified by a calculated number also called "magnification". When this number is less than one, it refers to a reduction in size, sometimes called minification or de-magnification.[2]

## THE LIMITS OF HUMAN VISION

Webster defines resolution as the ability of an optical system to make clear and distinguishable two separate entities. Although clinicians have routinely strived to create bacterial-free seals, the resolving power of the unaided human eye is only .2

mm. In other words, most people who view two points closer than .2 mm will see only one point.[3]

**Type of magnification system[1]**

The magnification-enhanced dentistry incorporates the use of two types of optical magnification systems:

(a) loupes

(b) surgical operating microscope.

The most common magnification system used in dentistry is the magnification loupes. Primarily, loupes consist of two monocular microscopes, with side-by-side lenses, angled to focus on an object to form magnified images with stereoscopic properties that are created by the use of convergent lens systems. Wide ranges of magnifications are available in loupes, ranging from × 1.5 to × 10. It is always ideal to adapt to magnified vision by initially using loupes, which enable the operator to adjust to the eye training exercise and changes in hand-eye coordination. Although loupes are widely used, their major disadvantage is that the eyes converge to view an image (Keplerian optics), which can result in eye strain, fatigue, and even vision changes with the prolonged use of poorly fitted loupes. **There are three types of loupes.**

***SIMPLE LOUPES***

Simple loupes consist of a pair of single, positive, side-by-side meniscus lenses. Each lens has two refracting surfaces, with one occurring as light enters the lens and the other when it leaves. Its main advantage is that it is cost-effective. The disadvantages are it is primitive with limited capabilities and are highly subjected to spherical and chromatic aberrations, which distort the image of the object.

***COMPOUND OR TELESCOPIC LOUPES***

Compound loupes or telescopic loupes consist of multiple lenses with intervening air spaces, thus allowing adjustment of magnification, the working distance (WD), and depth of field without an increase in size or weight.

***PRISMLOUPES***

Prism loupes are optically most advanced containing Pechan or Schmidt prisms that lengthen the light path through a series of mirror reflections within by virtually folding the light so that the barrel of the loupe can be shortened. They produce better magnification, larger fields of view, wider depths of field, and longer WDs. This is a feature that dentists should seek when selecting any magnifying loupe because an achromatic lens consists of two glass pieces, usually bonded together with clear resin. The specific density of each piece counteracts the chromatic aberration of the adjacent piece.[1]

Different system of loupes

1. Fill-up loupes

2.TTL loupes(Through-The-Lens)

## Surgical operating microscope

In dentistry, operating microscopes are designed on Galilean principles. They incorporate the use of magnifying loupes in combination with a magnification changer and a binocular viewing system so that it employs parallel binoculars for protection against eye strain and fatigue. They also incorporate fully coated optics and achromatic lenses, with high resolution and good contrast stereoscopic vision. Surgical microscopes use coaxial fiber-optic illumination. This type of light produces an adjustable, bright, uniformly illuminated, circular spot of light that is parallel to the optical viewing axis. Due to its shadow-free light, visualization of pathologies, documentation, motion videography, and management of all dental and surgical procedures can be effectively performed under unobstructed vision. Patients can be counselled better as they can directly visualize the magnified image on the screen due to the beam splitter video camera attached to the microscope.[1]

**ADVANTAGES OF MAGNIFICATION DEVICES**

Three primary advantages were identified in relation to the usage of magnification device in endodontics, namely,

(1) enhanced visualization,

(2) improved working posture, and

(3) increased referral.

## USES OF VARIOUS LEVELS OF MAGNIFICATION

Adjustments of magnification can be categorized into three levels:

Low magnification (3x – 8x) Appropriate for examination of tooth orientation and positioning of bur or ultrasonic tip. The wide field of view allows comparisons of the adjacent anatomic landmark. This magnification level is used in loupes in which straightforward cases can still be competently performed.

Medium magnification (8x – 16x) Commonly used in non-surgical and surgicalendodontic procedures as it provides an acceptablefield of view and depth of field. It is used forperforming intricate procedures such as perforationrepair, separated instrument retrieval and surgicalprocedure which requires higher precision andaccuracy.

High magnification (16x – 30x) Employed mostly for close-up examinations and inspections of minute anatomies, e.g., calcified canal orifice and minute cracks. Apart from having a diminutive field of view, immediate loss of focus may ensue following minor movements. The subtle color variance between secondary and tertiary dentin in teeth with calcific metamorphosis can be distinguished at this level.[4]

## Ergonomics

In the desire to enlarge the object the dentist is viewing at the dental chair; the practitioner may move closer to the object and bend over to see object. It was found that awkward posture also plays an important role in musculoskeletal disorders. Due to the sensitivity and accuracy requirements, dentists' heads and necks are bent forward to provide optimum visual conditions. These conditions cause awkward postures and may lead to occurrence of musculoskeletal disorders in the neck and back.[3]

Therefore, preventing the discomfort are particularly important. One of the main objectives of the ergonomics in the recent decades has been to prevent discomfort.

It seems that using magnification lenses can prevent awkward posture in dentists because of its increased magnification and clarity of vision.

The knowledge of the basic ergonomic motion is necessary for understanding of efficient workflow of microscope.

**THE LAWS OF ERGONOMICS[3]**

An understanding of efficient workflow using an OM entails knowledge of the basics of ergonomic motion.

Ergonomic motion is divided into 5 classes of motion:

- 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.
- Class V motion: movement that involves twisting or bending at the waist.

**Advantages of magnification**

Three primary advantages were identified in relation to the usage of magnification device in endodontics, namely, (1) enhanced visualization, (2) improved working posture, and (3) increased referral.[5,6,7]

**USE OF MICROSCOPE IN DENTISTRY [3]**

**Use in Diagnosis**

**Cracked tooth Syndrome**: An isolated area of enamel may craze or crack when subjected to a blow or when a patient bites into something hard. Although the damage may initially incite pain, the cushioning effect of the underlying dentin tooth structure may be resilient and sufficiently forgiving to keep the crown intact. Most of these superficial fractures are relatively undetectable with normal vision, but when viewed under high power, hairline cracks appear as crevasses .

**Soft Tissue Evaluation**: - Patients often present with pain and related symptoms that indicate the presence of inflammation \infection, but visual and radiographic

evaluations do not always clearly identify the problem. at times an infected intraosseous lesion trephines the labial plate but defies detection by normal diagnostic procedures. Under high levels of magnification, an inconspicuous sinus tract may be located.

**Gingival bleeding**: Directing a minor occlusal angled force at the gingival margin of the restoration often discloses a micro movement that is not visible to the eye but is evident and easily detected when viewed under high power.

**Gingival swelling**: Foreign objects, such as popcorn kernels, celery husks, fruit pits, tooth chips, meat, fish bones, and even fingernail clippings, are often wedged and compressed between teeth and beneath points. The resulting swelling and persistent bleeding of the associated tissues make the location, identification, and removal of the impediments difficult, challenging, and painful. when managing these situations, the naked eye and the illumination provided by a normal overhead operating lamp are often inadequate; compromise the treatment, escalate the degree of procedural difficulty, and create unnecessary stress for both the patient and doctor. These obstructions when viewed under the microscope are identified, grasped, and removed with ease.

**Occlusal caries detection**: The use of an operating microscope in diagnosing occlusal caries in the clinical setting is important to establish the utility of this non-invasive technique.

**Sisodia N et al (2014)** conducted in-vitro study to test the accuracy and reproducibility in the detection of incipient occlusal caries and treatment decision-making using unenhanced visual–tactile technique and low-level magnification by the use of loupes and surgical operating microscope. Sixty extracted human posterior teeth were assessed by two examiners using ICDAS- II index and CPI- TN probe, with and without magnification. Histopathology was used as the gold standard for the diagnosis of caries and treatment decision-making. It was concluded that the use of low-level magnification would allow for easier and more reliable incipient caries detection.[5]

**Coronal preparation:**Restorative dentistry particularly when aesthetics is crucial to success, demands marginal accuracy. Even minute discrepancies in chamfer finish

can mean the loss of gingival integrity and an uncomplimentary exposure of the crown-root interface, precision is essential to prevent adverse tissue responses and to achieve patient satisfaction.

**Atlas AM et al (2022)** conducted an in vitro study to compare marginal fits of CAD-CAM crowns fabricated after initial preparation with loupes and subsequent preparation refinement with either loupes or a microscope. This study demonstrated that the higher magnification used during tooth preparation played a significant role in the size of marginal gaps present around CAD-CAM crowns. Crown preparations finished by using fine-grit diamond rotary instruments with a microscope at a higher magnification than loupes resulted in a more precise marginal fit with smaller gaps.[6]

**Impression quality**: Indirect restorative procedures reply on capturing an impeccable image of the entire crown preparation as well as untouched coronal root junction. Any deviation in this moulage representation is transferred to the dye, a restorative misfit and, when seated lends itself to Marginal leakage, examining the impression surface for imperfections, distortions, and marginal inadequacies under high magnification at the time the impression is taken eliminates laboratory guesswork and avoids the disappointment and frustration of redoing the restoration at a later appointment. A simple rejection of a flawed impression is a professional and financially sound decision.

**Evaluating the restoration under surface**: It is not unusual for the under surface of a metal casting or ceramic-baked restoration to have surface irregularities. These small imperfections, imperceptible to the naked eye but visible under high magnification, can interfere with the seating of the restoration, alter occlusion, and if seated, invite marginal leakage. Worse yet, the imperfect crown-tooth interface can be likened to a wedge when forced to place, and as such may fracture the prepared tooth at the point contact.

**Restoration delivery and Polish:** The final seating of a precision crown normally requires little adhesive and only a light intraoral polish. However, the slightest amount of residual cement left on the root crown interface margin stimulates an adverse response from the approximating tissue. The subsequent and painful loss of gingival integrity leads to server inflammation and recession. The restoration margins are ultimately exposed, and all aesthetic quality is lost. Examining the surfaces with

a high level of magnification and illumination is the only way one can be assured of crown-root interface cleanliness.

**Bonded Restoration:** -The bonded restoration presents unique and more difficult finishing requirements and therefore demands greater care and precision to create a margin that is smooth and non-irritating to the gingival issues. As one progress through the regimen of finer and finer burs and finishing disks, it becomes more difficult to evaluate the surface texture of the finished Cristal edge. Only when this junction is fine-tuned under magnification can one be assured that the gingival tissues will not become inflamed, bleed, recede, or expose the critical root-filling interface.

**Eggmann F et al (2022)** conducted a study to assess the effect of magnification devices on procedure quality in restorative dentistry. It was concluded that loupes with 2.5× magnification increase the accuracy of two-dimensional preparations while they have no significant effect, favorable or otherwise, on the accuracy of complex, three-dimensional cavity preparations of untrained dental students.[7]

## Uses in Endodontic Therapy

**Coronal Access:** Pulp responds to age, repeated restorative procedures, trauma from injury, and occlusal wear by depositing layers of amorphic calcified dentin. In a chamber that has obliterated itself with secondary and tertiary dentin, the possibility of perforating the floor during endodontic coronal access becomes a real concern. Unless one is using high levels of magnification when approaching the floor of the natural floor. Proceeding blindly without the aid of magnification invites perforation and subsequent failure.

**Locating orifices:** -It is no larger a delusion that a root has a single canal and single exit. Studies have indicated that the potential for multiple Canals and intracranial communication exists in virtually every root, and success and failure rest on locating and negotiating all these canal aberrations. The floor of a chamber when magnified and property cleared outlines pathways to the various canal orifices, Once located and identified, these minute openings become obvious, and the orifices are more easily negotiated with no. 06 or 08 stainless steel files.

**Perrin P et al (2019)** conducted a study to evaluate the performance of Galilean and Keplerian loupes in the endodontic lumen with and without integrated light. The naked eye (negative) and the microscope 6× (positive) served as control groups, and Galilean loupes 2.5× and Keplerian loupes 4.3× with and without a coaxial light source as experimental groups. It was concluded that the microscope offered highly superior results and the naked eye was insufficient to reach the visual threshold at any location.[8]

**Buhrley LJ et al (2002)** conducted an in vivo study to determine if the surgical operating microscope and/or dental loupes could enhance the practitioner's ability to locate the second mesiobuccal canal (MB2) canal of maxillary molars, in a clinical setting. The participating endodontists documented 312 cases of root canal therapy on maxillary first and second molars. They concluded that the use of magnification in combined groups leads to an MB2 detection rate approximately three times that of the non-magnification group and that the use of no magnification results in the location of significantly fewer MB2 canals. Based on these results, more emphasis should be placed on the importance of using magnification for locating the MB2 canal.[9]

**Locating and retrieving foreign objects**: A high-powered microscope provides enhanced vision and illumination for simple re-treatment of a canal or re-treatment of post and core-treated tooth. It also aids in retrieving fragmented or separated instruments that might have occurred during the cleaning and shaping of a canal. Finding and removing these canal-blocking obstacles without perforating the root requires careful and precise circumferential toughing of the approximating dentin with an appropriate ultrasonically powered alloy or diamond tip-toughing without magnification invites perforation and failure.

**Gencoglu N and Helvacioglu D (2009**): - stated that operating dental microscope microscopes are essential for the removal of fractured instruments. The enhanced vision with magnification and illumination from a microscope allows clinicians to observe the most coronal aspects of broken instruments and to remove them without any perforations.[10]

**Repairing iatrogenic and Idiopathic perforations**: -Locating and repairing canal periodontal ligament communications through a delicate and precise intracanal

access can only be accomplished with the aid of enhanced vision and illumination from a high-powered microscope.

**Endodontic Surgery**: -Probably the most significant contribution of the microscope in endodontic therapy occurs when surgical access to an endodontic problem becomes the only alternative to tooth extraction. The success of endodontic surgery is often compromised by anatomic restrictions and root aberrations (i.e. the number and location of canal exits). To improve the chances of clinically detecting multiple exists and isthmi and to parallel the retro preparation and root-end filling to the root axis, one must depend on intense illumination and an unobstructed magnified view.(Figure 30)

**Sajjanar A et al (2018)** conducted a study to compare the time it took to perform endodontic treatment in primary teeth with or without the use of a magnifying loupe. 60 cases of deciduous molars were selected. They were categorized into two group's i.e., 30 patients with use of magnifying loupe and 30 patients without use of magnifying loupe. It was concluded that less time was required in treating patients using magnifying loupes than without the use of loups.[11]

**Slaton CC et al (2003)** conducted an in vitro study to evaluate and compare the effectiveness of visual enhancements as aids in identifying artificially created dentinal cracks in resected root ends. Statistically, the Orascope ($p = 0.02$) was significantly superior, whereas using unaided/corrected vision ($p = 0.99$), loupes ($p = 0.88$), or the microscope ($p = 0.14$) was not significantly better than guessing.[12]

## Recent advances in magnification – Head Mounted Microscope

It has a magnification range of 2.9× to 7.0×. Its working distance is 11.81–27.56 inches. It is autofocused and has an integrated autofocus camera. It also has integrated light optics. Its field of view is 1.18–8.82 inches and has shadow-free illumination.[13]

## Conclusion

The increased magnification and the coaxial illumination have enhanced the treatment possibilities in non-surgical and surgical endodontics. Treatment modalities that were not possible in the past have become reliable and predictable. We can state that microscope in endodontics represent what the discovery of x ray

radiations represented for dentistry more than 100 years ago. As today we cannot imagine dental office without Xray machine,in the same way we can state that the day is not far away when dentistry will be entirely and diffusely performed under the operating microscope. All endodontic graduate programs are now teaching its use as part of their curriculum. The only limitation that exists for operating microscope is the imagination and it is certainly a most useful adjunct in the continual search for endodontic excellence.

## Reviews


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