

Review Article

The impact of dental operating microscopes on the success rates of endodontic treatments

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ABSTRACT

Recent advancements in dental technology, such as magnification devices like loupes and surgical microscopes, have greatly improved the accuracy and quality of root canal treatments. Dental operating microscopes (DOMs) have become widely accepted in endodontics, providing enhanced visualization and facilitating precise identification of anatomical landmarks, root canal orifices, and pulp remnants. The increased magnification and illumination offered by DOMs have improved treatment outcomes by enabling more efficient removal of bacteria, debris, and obturation materials from the root canal system. Studies have shown that the use of DOMs can significantly increase the success rates of endodontic treatments, allowing for the identification and treatment of even the smallest canals and anatomical variations. Additionally, DOMs enhance ergonomics, patient communication, and documentation in dental practice. However, challenges such as cost and limited office space hinder their widespread use. Increased education and awareness of the benefits of operating microscope utilization are essential for its broader adoption in endodontic procedures.

Keywords: Dental operating microscope, Endodontics, Magnification, Visualization

INTRODUCTION

Endodontic treatment is a dental procedure that involves the removal of infected or damaged pulp tissue from within a tooth. The objective of successful endodontic therapy is the thorough mechanical and chemical cleansing of the entire root canal system, followed by its complete obturation with an inert filling material.¹ Creating an ideal

access opening is one of the most important steps to ensure a successful endodontic procedure. At the same time, the inability to identify and adequately treat all the canals of the endodontic system is a major cause of treatment failure and the persistence of disease.^{2,3} Recent developments in dental technology have improved the clinician's ability to treat elusive regions within the oral cavity, increasing the efficiency and quality of root canal treatment. For

example, in endodontic surgery, the advent of microsurgical instruments has brought technical changes to the approach to root canal preparation. Along with the utility of such instruments, the use of well-focused illumination and magnification devices has been recommended as a standard of care.⁴ Loupes and dental operating microscopes (DOM) are the magnification devices most frequently utilized in the field of endodontics.⁵ Working with such devices has become a widely accepted practice in conventional and surgical endodontics. These advancements have boosted the accuracy of endodontic procedures. These developments have allowed dentists to undertake surgeries that were long thought to be either impossible or doable only by dentists with exceptional skills or good fortune. The most significant change is the widespread use of operating microscopes.⁶ In addition to ophthalmology, operating microscopes have also been utilized for decades in the disciplines of neurosurgery, reconstructive surgery, otorhinolaryngology, and vascular surgery. It has only been used in dentistry for about 15 years, but its use in endodontics specifically has completely changed the face of this specialty around the world.⁶ Endodontic therapy could previously only depend on tactile sensitivity and radiographs, which were required to view the interior of the root canal system. When treating an individual with endodontics, the dentist has to primarily rely on their tactile sense with limited visual cues. Before DOM, clinicians could only "feel" the presence of a problem (a ledge, a perforation, an obstruction, a damaged instrument), and the clinical management of the condition was less predictable and relied on chance. Tactile dexterity, mental imaging, and patience were all put to the test during endodontic treatments because of the lack of visual feedback.⁶ The growing utilization of the DOMs in endodontics has resulted in documented improvements in both clinical effectiveness and skill, along with a reduction in iatrogenic incidents.⁷ Since 1998, the Commission on Dental Accreditation (CODA) has included DOM as a requirement in its proficiency standards for post-graduate endodontic residencies. As a result, the DOM has become an essential component of the field of endodontics, experiencing a consistent rise in adoption, with usage rates increasing from 52% in 1999 to 90% in 2008.^{7,8} Multiple studies have provided evidence of the clinical efficacy of the dental operating microscope (DOM) in enhancing the outcomes of various endodontic procedures.

METHODOLOGY

The present research is based on a comprehensive literature search conducted on 23 May 2023, in the Medline and Cochrane databases, utilizing the medical subject headings (MeSH) and a combination of all available related terms. To avoid overlooking any potential research, a manual Google Scholar search was conducted using the reference listings of the previously cited papers as a starting point. We scoured the literature on the impact of dental operating microscopes on endodontic treatment

success rates. There was no date, language, participant age, or publication type restrictions.

DISCUSSION

The lasting success of both primary and retreatment cases in endodontics depends heavily on the precision of techniques employed during the cleaning, shaping, and filling of root canals. These techniques are significantly enhanced through the use of improved lighting and magnification, further ensuring their accuracy.⁸ A comprehensive understanding of dental morphology, as well as the precise location and cleanliness of the root canal system, are essential requirements for successful endodontic treatments. To enhance the quality of these treatments, endodontists have sought out new technologies. The development of DOM is often regarded as one of dentistry's greatest accomplishments because of the positive impact it has had on the efficiency and effectiveness of so many different types of treatment. Selden was the first author to publish a paper on the applicability of DOM to conventional endodontic therapy.⁹ Commercially available microscopes offer adjustable magnification that typically ranges from approximately 4x to 25x, while loupes generally provide fixed magnification between 2.5x and 6x. Magnification can be categorized into low magnification (around 2x-8x), mid magnification (approximately 8x-16x), and high magnification (roughly 16x-25x). These different levels of magnification are applicable for various stages of both nonsurgical and surgical endodontic procedures. Low magnification is primarily used to gain an overall view of the treatment area, mid magnification is employed for the main steps in root canal therapy and endodontic surgery, and high magnification is utilized for precise identification of small structures and detailed documentation. The use of a microscope significantly enhances the accuracy of practitioners during these procedures.¹⁰ It is important to note that there is a period of adjustment and adaptation when working with mid and high magnification, as practitioners need to be mindful of their movements to prevent unintentional actions on delicate anatomical structures. Due to the small-scale nature of the work environment, new micro-instruments have been introduced to the dental field.

DOM has been shown to be helpful in addressing complex situations in endodontics and dental surgery through several experiments and clinical data, but its adoption has been slower than anticipated.¹¹ To improve the efficacy and success rate of endodontic treatment, dentists must still have a thorough understanding of the anatomy of the pulp chamber and root canal system; however, it is anticipated that the microscope will have a growing impact on all treatment procedures in the coming years.¹¹ DOM can be used effectively in both surgical and non-surgical endodontic procedures. Even in the apical third, every difficulty encountered in the straight portion of the root canal can be easily observed and managed with the first technique. For the latter, the microscope enables a

thorough examination of the apical portion of the root, facilitates the preparation of retrograde cavities, and enhances apical resection with an optimal bevel.¹² DOM enables the dentist to identify pulp chamber anatomical landmarks, root canal orifices, pulp remnants, cracks, resorption, and pulp stones with greater clarity. The enhanced visibility of specific canals during instrumentation permits endodontists to more efficiently insert files into canals.¹³ One study reports on the utility of DOM in four retreatment cases that showed recurrent infection despite the repeated use of antibacterial endodontic dressing with calcium hydroxide. The use of DOM revealed the existence of longitudinal fractures that had previously remained undetected on clinical inspection and radiographic examination.¹⁴ Treatment options for damaged instrument retrieval which include the use of ultrasonic endodontic equipment enhanced vision by means of DOM have been observed to provide a generally positive prognosis. These studies note that a successful outcome can be achieved by a combination of early actions of collecting the broken tool, disinfecting the root canal and peri-radicular tissues, and using antimicrobials.¹⁵ The authors recommended performing entire treatment procedures using DOM in cases where its use is justified.¹⁴ It was extremely helpful for removing separated files in the pulp chamber or root canal system, as well as identifying calcified or missing canals.¹⁴ The increased magnification and illumination provided by DOMs also enable practitioners to more effectively remove bacteria, debris, and obturation materials from the root canal system, which is key to successful root canal therapy. This is particularly important in cases where the canals are curved or narrow, as the use of DOMs can help prevent over-instrumentation or perforation of the root canal walls.¹⁶

Although the operating microscope is now regarded as a potent clinical instrument, it was not initially adopted by all endodontists. However, the authors of a study conducted by Monica et al observed that the use of the DOM on an infrequent or intermittent basis during endodontic treatment had a detrimental influence on the final result because it prolonged appointments and disrupted clinical procedures.¹⁴ Among the benefits of the DOM are magnification, appropriate illumination, improved treatment quality and precision, and enhanced communication through an integrated video system.¹⁷ The use of an operating microscope provides other advantages, including accurate access cavity preparation, precise identification of root canals, and effective removal of pulpal stones or fractured instruments.¹⁸ This is especially crucial for endodontic treatments, where the removal of bacteria and infected tissue is crucial to the success of the procedure. With proper training in DOM use, endodontic procedures can be performed faster and with fewer errors. The microscope improves the overall treatment quality and encourages endodontists to update their learned concepts, which positively impacts their clinical performances.¹⁹ The presence of light enhances the apparent resolution, which refers to the ability to perceive two closely situated objects

as separate and distinct entities.⁶ Moreover, studies have shown that the use of DOMs can increase the success of the treatment of endodontics by up to 10-15%. This is because DOMs allow practitioners to identify and treat even the smallest canals and anatomical variations that may not be visible with the naked eye or with traditional dental loupes.^{20,21} In addition to improving the success rates of endodontic treatments, DOMs have also been shown to reduce the hazard of procedural errors and complications, such as caries, missed canals, instrument fractures, and perforations. This is because DOMs provide better visualization and control during the procedure, which allows practitioners to work more efficiently and accurately.²² Furthermore, another benefit is improved ergonomics, so DOMs can be adjusted to accommodate the individual needs of the practitioner, which can help reduce the risk of musculoskeletal disorders and other occupational injuries related to dental work. Additionally, they provide improved patient communication, so the use of DOMs can help practitioners explain dental conditions and treatment options to patients more effectively. Patients can see the condition of their teeth and gums in greater detail, which can help them make more informed decisions about their dental care.¹⁶ Moreover, it provides easy access to high-quality images and videos captured by DOMs which can be used for documentation and education purposes. These images can be stored and shared digitally, which can help improve communication among dental professionals and lead to better patient outcomes.¹⁶ Due to these benefits, the American Dental Association made a formal request in 1998 for all graduate programs in the United States to incorporate the teaching of operating microscope utilization in both nonsurgical and surgical endodontic procedures.²³ Nonetheless, some factors decrease the widespread use of microscopes. The most significant factor is the exorbitant price. Additionally, challenges may arise, such as limited office space or a lack of motivation to utilize the microscope, often stemming from a lack of familiarity or understanding about its benefits.

CONCLUSION

The use of DOM, which enhances clinical performance in numerous treatment procedures, is often regarded as one of dentistry's greatest inventions. DOM has been shown to be useful in addressing complex problems in endodontics and dental surgery via various experiments and clinical trials, but its widespread adoption has lagged behind expectations. The use of DOMs in dentistry provides many benefits beyond just endodontic treatments. The enhanced visualization, accuracy, and ergonomics can improve the quality of care for cases and decrease the risk of occupational injuries for practitioners. Improved patient communication and documentation can also lead to better overall outcomes for dental care.

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