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Research Article

Expanding the Operating Field in Endodontics: From magnification loupes to microscope

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ABSTRACT

This study sought to perform a review of the literature on the use of magnification during endodontic procedures. The literature used in this review was obtained from databases and only articles published after 1999 were considered. The terms “microscopy”, “endodontics”, “magnification” and “loupes” were used. Each abstract was read to determine whether the information in the article included discussions on the use of magnification in endodontics (n=18). It was found that microscopes are more advantageous to endodontics, particularly when root canals need to be located. The benefits provided by magnification devices improve the success rates of endodontic procedures. The use of these devices is recommended for all steps of endodontics treatment and retreatment.

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Introduction

The operating field in endodontics is so restricted that professionals cannot obtain direct visualization. As a result, these professionals frequently adopt numerous strategies in order to improve visualization and to achieve treatment success [1-3]. Although radiography is an important resource, it presents only a two-dimensional image [1,4]. Thus, the use of a magnification system can facilitate the three-dimensional examination of dental anatomical structures [4].

Magnification lenses produce a clearer and larger view of the operating field [5] and therefore aid the professional in providing a more accurate diagnosis, in making smaller perforations, in detecting micro fractures, in eliminating obstacles from the root canal, in identifying the isthmus, and in better interpreting particular complexities of the root canal [1,3,6]. Thus, these lenses support visualization and proper root canal instrumentation, factors which were previously considered unattainable and which were therefore neglected [7].

Magnification devices include loupes and microscopes [8]. The latter are widespread in the field of endodontics, since they emit good illumination and have a higher magnification power than traditional loupes [9].

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Because magnification systems can prove very important during endodontic treatments—from root canal location to restorative treatments [10, 11] — This study sought to perform a review of the literature on the use of magnification during endodontic procedures.

Methods

The literature used in this review was obtained from the following databases: Science Direct, the Scientific Electronic Library Online (SCIELO), the Latin American and Caribbean Health Sciences (LILACS) database, and the National Library of Medicine (MEDLINE). Articles published after 1999 were considered.

First, only medical subject headings such as “microscopy” and “endodontics” were used to find articles. However, these terms did not produce enough articles on the use of magnification in endodontics. For this reason, additional terms that were not indexed, such as “magnification” and “loupes”, were also used. The terms were both combined and used in isolation. In the second step, each abstract was read to determine whether the information in the article included discussions on the use of magnification in endodontics (n=18). After the abstract review, a content summary was performed (**Chart 1**)

Results

(**Chart 1**) This review demonstrates that, out of all of the studies that addressed the use of a magnification system in endodontics, the majority (n =15) considered the use of an operating microscope

Chart 1. Scientific studies on the use of magnification in endodontics

Authors	Study Objective	Magnification Device	Conclusion
De Carvalho, Zuolo [12], 2000	To determine whether the use of microscopes can aid in the identification of canal orifices in mandibular molars	Microscope at X8.0-X13.0	The use of a microscope increases the number of root canal orifices located
Baldassari-Cruz et al. [13], 2002	To evaluate the influence of using microscopes to detect the mesiolingual canal	Microscope at X25.0	The use of a microscope increased the detection of canal orifices
Buhrley et al. (9), 2002	To determine whether the use of loupes and microscopes enhances the ability to locate the second mesiobuccal (MB2) canal	Loupes at X2.0 and microscope at X4.0	The use of any magnification aid increased the number of MB2 canals located
Khayat [20], 2002	To review the use of operating microscopes in endodontic treatment	Microscope	These magnification and illuminations increased treatment options in surgical and nonsurgical procedures
Yoshioka et al. [19], 2002	To compare the detection of root canal orifices by the naked eye, loupes, and microscopes	Loupes at X3.3 and microscope at X4.6-12.0	The microscope was found to improve accuracy in the detection of canal orifices
Rampado et al. [15], 2004	To assess the benefit of microscopes in improving endodontic performance	Microscope	Microscope use improved cavity preparation and the accuracy of identifying canals
Coutinho et al. [16], 2006	To evaluate the influence of microscope, use on the detection of mesiolingual canal orifices	Microscope at X25.0	The use of a microscope increased clinicians' ability to locate the mesiolingual orifice
Taschieri et al. [21], 2006	To complement ultrasonic root end preparation with magnification loupes or endoscopes	Loupe at X4.3 and endoscope	The endoscope provided better visualization but it required more procedure time
Kersten et al. [6], 2008	To investigate the frequency of microscope, use among endodontists	Microscope	The microscope was used most for root end inspection, for locating canals, and root-end filling. The use increased from 52% in 1999 to 90% in 2007
Bowers et al. [18], 2010	To investigate the effect of magnification on endodontic skills	Loupe at X2.5 and microscope at X8.0	The use of magnification improved fine motor skills at all levels of experience
Carr, Murgel [2], 2010	To provide basic information on how magnification is used in clinical endodontic practice	Microscope	The use of microscopes provides precision care in dentistry
Del Fabbro, Taschieri [24], 2010	A systematic review of the literature on the use of magnification in endodontics	Loupes and microscope	No significant difference in outcomes was found among patients treated using different magnification devices
Feix et al. [1], 2010	A review to evaluate the use of microscopes in endodontics.	Loupes and microscope	Magnification provides a significant improvement to the field of endodontics, offering better quality of work and communication between professionals and patients
Taschieri et al. [8], 2010	To describe and compare different magnification devices	Loupes, endoscopes, and microscopes	Magnification seems beneficial for conventional and surgical endodontics

Authors	Study Objective	Magnification Device	Conclusion
Setzer et al. [19], 2012	To compare two surgical techniques (one with magnification and one without)	Microscope and endoscope	Endodontic microsurgery, which was influenced by magnification was significantly more successful
Kumar, Khambete [4], 2013	A review of the literature on the use of microscopes in endodontics	Microscope	The use of a microscope provides greater visibility, and endodontic procedures can be done in less time, with fewer procedural errors
Perrin et al. [3], 2014	To evaluate the visual accessibility of the endodontic working field with and without magnification	Loupe at X2.5	Magnification did not improve visibility of the root canal. Dentists over 40 years were dependent upon microscopes
Iandolo et al. [17], 2016	A review of the literature on modern technologies in endodontics	Microscope	The microscope provides a better power of resolution, making the human eye able to observe details

Discussion

The current study evaluated the use of magnification in endodontics. This review revealed that most studies on the topic have emphasized the importance of a magnified operating field for endodontic treatment [1, 4, 6, 9, 12-17]. The benefits of a magnified operating field have been highlighted by several authors [1, 2, 4, 8, 9, 12-15, 17-20].

Although most studies have emphasized the use of microscopes, other forms of magnification can be employed in the field of endodontics, such as magnifying loupes and endoscopes. The former has limited magnification power when compared to microscopes, since the lens settings reach only 6x magnification [1, 2, 19, 20]. Additionally, loupes have been identified as the cause of visual fatigue when used for long periods [1, 20]. This situation may occur because the loupes' optical system is convergent, which leads to eye strain.

Yoshioka et al. [14] concluded that loupes were not effective for locating root canals in extracted human teeth. In contrast, Buhrley [9] performed an *in vivo* study and determined that magnification loupes were as good as microscopes for locating root canals. This important divergence may have occurred because of the difference in study designs

The use of an endoscope has been recommended in the field of endodontics since 1996. The equipment is composed of a camera and a light source and is attached to a monitor [8]. However, few scientific studies have evaluated the use of this device [19, 21].

When magnification devices are used, the main advantage reported is that less time is required for procedures. Taschieri et al. [8], stated that the time required for endoscope use seems shorter than the time required for the use of an operating microscope, since the endoscope is more versatile and easier to adjust. Because endodontic treatment itself already requires extensive hours of clinical work, the advantage provided by an endoscope is an important factor to consider. However, Taschieri et al. [21] mentioned that the time spent may be longer if an endoscope is used for surgical endodontics, since there is a need for pauses in order to clean the lens when hemostasis is difficult to achieve. Nevertheless, when compared with magnifying loupes, these authors found that the endoscope provided better visualization of the operating field, a result which facilitates compliance with a more rigorous and precise surgical protocol. This level of accuracy can also increase

treatment success rates [21].

Microscopes used under proper illumination and magnification, have been found to make an important contribution to root canal location and surrounding dentin differentiation [9, 12-15]. This factor is important for endodontic treatment, since microscopes make it easier to identify and treat all root canals and also aid in the conservation of dental structure, which facilitates the subsequent steps.

Feix et al. [1] found that the quality of endodontic treatment was improved when microscopes were used. Through a literature review, the authors emphasize that microscopy provides a detailed view of the pulp chamber and canal entrances, allows for ideal access to the root canal complex, and produces proper biomechanical preparation and obturation. Additional benefits such as perforation treatment have been reported; these treatments may become more accurate due to the enlarged operating field. These conditions ultimately lead to a more favorable prognosis. Iandolo et al. [17] emphasize that the microscope is an essential device for preventing iatrogenic issues, since it produces clearer visualization of the operating field.

Microscopes are considered most effective in biomechanical preparations because their magnification power provides greater visualization of anatomical details [4, 19]. This field of vision can provide clarity as far as the apex root portion [2]. Thus, some authors [4] recommend the use of microscopes even in the final treatment step: microscopes enable a proper evaluation of root conditions, which need to be dry in order to ensure complete obturation [4].

In addition to the benefits they provide for treatments and to dental procedures in general [2, 4, 19], operating fields magnified by microscopes can also be useful in retreatment cases. These cases presented higher success rates, particularly in those that required the prior removal of intracanal posts or broken instruments [4].

The use of magnification can also produce many advantages for the professionals. Khayat et al. [20] emphasize that endodontists who use magnification are able to work in a more comfortable and ergonomic posture. This posture is possible because magnifying lenses bring the operative field closer to the professional, thus avoiding inclination of the body and neck or misaligned spinal positions. Microscopes are particularly limiting, since they the block professional's physical proximity to the patient [20, 22].

Bowers et al. [18] report a positive effect of magnification on

psychomotor skills. These authors evaluated the influence of different magnification systems on fine motor skills through a manual precision test. They found that the target accuracy, as proposed by the test, was higher when magnification was used.

Though the advantages of magnification devices have been touted by most authors researching this subject, is important to emphasize that these devices should be implemented with caution. Technical knowledge and training are required to ensure that the professionals can make the most of the advantages provided by these instruments [1, 23].

Another aspect to be considered is the cost of magnification systems, which demand a substantial investment. However, the price tag can be considered low in the long run if all of the benefits reported herein are factored into the cost, particularly in terms of occupational health.

It is important to note that, before making any investment, professionals should use the device for a trial period in order to confirm their ability to become accustomed to the techniques and changes required.

Conclusion

Microscopes are more advantageous to endodontics, particularly when root canals need to be located. The benefits provided by magnification devices improve the success rates of endodontic procedures. The use of these devices is recommended for all steps of endodontics treatment and retreatment. However, testing a device before purchasing it is encouraged in order to ensure one's ability to benefit from its potential advantages.

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