

Review Article

Benefits of Utilization of Magnification in Dentistry: A Review

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Abstract

The advent of micro dental treatments has made necessary that dentists improve the visual acuity of the operating field to diagnose early and to treat those areas with greater accuracy. The use of magnification devices in dentistry enhances visualization and improves ergonomics. Various alternatives in the use of magnification exist for all clinicians from introductory magnification systems, like single lens loupes, to high powered dental operating microscopes. A tremendous opportunity exists for all the clinicians to drastically improve their vision by use of magnification and illumination. This changing narrative of practicing dentistry made the authors search for literature on magnification in dentistry. An extensive literature search was performed in the Medline database to understand the nature of magnification devices used in dentistry. This narrative review depicts the present state

of magnification devices used in dentistry, their specific applications within different areas of dentistry. The paper also discusses the factors that influence their usage, advantages, and shortcomings, as well as the significances of magnification in various fields of dentistry. This review encourages members of the dental community to implement magnification in their practice for the best outcomes.

Keywords: Single Lens Loupes; Microscopes; Micro Dentistry; Periodontics; Oral Surgery; Prosthodontics

1. Introduction

Since the introduction of microsurgical principles in dentistry, many areas of dentistry have adopted them for better patient outcomes. Endodontics has developed

new techniques for root canal treatment, to enhance the visualization of the surgical field [1, 2]. In this effort various magnification devices like surgical microscopes, endoscopes, and magnifying loupes have added advantage to the operator for better visualization [2-4]. These are also associated with benefits for the patient in terms of improvement of clinical and radiographic outcomes. Similarly, periodontal microsurgery has benefited a lot after adopting these techniques and magnification devices [5-7]. Optical magnification has not only expanded the horizons of periodontics but also that of dentistry overall. Many dentists and specially periodontists have used microsurgical principles to enhance visual acuity and the accuracy of existing surgical techniques to broaden the scope of periodontics, with the knowledge and technology adopted from medicine [5]. Periodontal microsurgery could prove to be beneficial, leading to increasingly predictable results, minimally invasive procedures with reduced patient discomfort, rapid healing, improved esthetic results, and greater patient compliance. This review provides a brief overview of the use of magnification devices in dentistry and how it is used in endodontics, periodontal microsurgery and other disciplines of dentistry and to encourage the readers to adopt magnification.

2. Magnification Devices in Dentistry

The history of the microsurgical technique dates back to 1960. J.H. Jacobson and E.L. Suarez first introduced the microsurgical technique when they joined small vessels under an operative microscope [8]. The history of microsurgical techniques in medicine can be read elsewhere in the literature [9]. Thereafter, the development and refinement of microsurgical techniques and its clinical application in various specialties of medicine and dentistry have made much

progress throughout the world. This could not have been accomplished without the development of the Zeiss operating microscope (OpMi system), fine micro instruments, and fine suture materials [9].

3. Use of Magnification Devices in Restorative Dental Practice & Endodontics

Dentistry requires precise motor skills along with keen visual acuity. Many options are available in the market to improve visual acuity from simple loupes to surgical microscopes [10]. Each has its own advantages and limitations, but they all help to improve accuracy beyond unaided vision. The high-powered magnification, such as 4x-6x or more, provides enhanced visual information for diagnosing and treating dental pathology compared to either the unaided vision or an entry level 2.5x magnification. In various areas of general dentistry, the increased visual detail provided by higher magnification eliminates any confusion in diagnosis and treatment planning, improves control in treatment delivery, permits a dentist to produce more ergonomic restorations, and enhances clinical outcomes compared to the clinical work performed with unaided vision. High powered magnification can be used in many aspects of general dental practice like restorative dentistry, fixed and removable prosthodontics, endodontics, pediatric dentistry, periodontics, and oral surgery [11]. The utilization of appropriate visual enhancement must be considered by dental professionals in order to make dentistry more accurate, comfortable, enjoyable and to decrease the risk of musculoskeletal injury [10]. Various magnifying devices are employed in dentistry ranging from simple loupes to surgical microscopes. The loupes are classified by their optical construction into single lens loupes, Galilean loupes, and Keplerian loupes [12]. Depending on the optical construction, various

magnification factors are possible. A typical magnification factor for Galilean loupes is 2.5× with a higher limit of 3.2×. Keplerian loupes allow a broader choice of the magnification factor. Due to practical reasons, it is commonly between 3.5× and 4.5× [12].

The wide variety of available loupe systems, the variability in natural visual acuity, and the influence of age and adjustments suggest that the impact of loupes on the quality of dental treatment rendered might be more complex than imagined [13]. For decades, loupes have been used by dentists for reasons of precision and ergonomics [14-16]. Since the 1990s, the operating microscope has been favored as a necessary part of dental equipment [17]. Dentists should be aware of their own visual ability and of the various methods available to compensate for their visual deficiencies. Magnification devices are recommended for both the dentists with low natural visual acuity and for one's with good visual acuity [12]. Price was found to be the most important aspect in making a purchase [13]. Requirements of the use of magnified vision in the United States and Canadian dental schools have been shown to vary greatly [16]. Efficient magnification improves a dentist's capability to identify caries and cracks in teeth, to differentiate among various colors, discern the interfaces between different surfaces and materials, detect microscopic interferences in fixed and removable metal frameworks, and aid in adjusting occlusal prematurities and polishing restorations [18]. The most common magnification devices that have been introduced in endodontics are loupes, surgical microscope, and, more recently, the endoscope [3, 19]. Modern microscopes can be easily positioned on the surgical field, and have reached an excellent balance over the complete range of movement for the surgeon to be able to obtain the proper focus [19]. The use of a

headlight provides a good line of sight illumination and eliminates the shadow. It also avoids multiple adjustments unlike the traditional overhead dental operating light [19].

The use of loupes and microscopes has been shown to improve clinicians working posture and reduce repetitive stress injuries related to bad posture [2, 20]. The facile nature of operation along with better ergonomics of fiber optic instrumentation allows the endodontist to diagnose and treat the problem with more efficacy. Clinicians have realized that the use of magnification can improve the outcome of dental procedures. Among the various magnification systems available, loupes have been the most popular, yet their magnification is limited [21]. So the use of surgical operating microscope (SOM) has been emphasized in endodontics with micro mirrors [22]. Uses of various magnifications are as follows 1) Low magnification such as 3x – 8x is used for examination of tooth, orientation and positioning of bur or ultrasonic tip. The wide field of view permits comparisons of the adjacent anatomic landmarks. This magnification level is used in loupes where simple cases can be competently performed [1]. 2) Medium magnification such as 8x – 16x is used in non-surgical and surgical endodontic procedures as it provides an acceptable field of view and depth of field. It is used for performing complex procedures like perforation repair, separated instrument retrieval, and any surgical procedure that requires higher precision and accuracy [1]. 3) High magnification such as 16x – 30x is used mostly for close-up examinations and inspections of minute anatomies like calcified canal orifices and minute cracks. Apart from having a reduced field of view, immediate loss of focus may occur with minor movements [1]. The advantages of the use of magnification devices in endodontics are enhanced

visualization, improved working posture, and increased referral [18, 23, 24]. A camera can be attached to the microscope to enable the clinician to take high resolution photos in order to explain the complexity of the case or its prognosis to the patients. Which helps them better understand the proposed treatment plan. The microsurgical approaches allow the clinicians to perform endodontic surgery with smaller osteotomies, shallow bevels, preparation of isthmuses, an examination of resected root surfaces, retro preparation in line with the root canal, and precise placement of new filling materials [23, 25]. However, the successful outcome of endodontic surgery depends to a large extent on accurate intraoperative diagnostics [26]. Also, endoscopy has been reported to provide the surgeon with outstanding vision and ease of use [27]. Many systematic reviews were carried out to assess the significance of magnification device usages and productivity in endodontics [2, 28-30]. However, the ability to appreciate the characteristics of magnification devices and the various levels of magnification will encourage clinicians to use them and eventually increase their proficiency to perform endodontic procedures, thus improving the outcomes [1].

4. Use of Magnification Devices in Periodontal Dental Practice

Various aspects of treatment for periodontal diseases or gingival problems require meticulous diagnostics. Magnification tools and microsurgical instruments, in conjunction with minimally invasive techniques provide the best solutions in such cases [31]. The aspects of relevance of treatments, duration of healing, reduction of pain and post-operative scarring can be improved for patients through such techniques [31, 32]. The dental operating microscope allows the operator to track more efficiently any residual irritating elements such as a

spicule of calculus or an enamel pearl that could explain the loss, or persistence of loss, of epithelial attachment in a particular area [31]. The use of the microscope and its higher magnification and illumination is useful in more critical zones, such as furcations, and possibly to complete the work in those places. This also contributes to a real learning experience on how to use the instruments in the most efficient and least traumatic way possible. Various microsurgical techniques in periodontics were developed with a better outcome and patient satisfaction by using magnification devices [7]. These devices have enhanced the efficacy of surgeon [5, 6]. Microsurgical principles have been developed to improve visual acuity, accuracy of existing surgical techniques and to widen the scope of periodontics with the knowledge and technology obtained from medicine. The benefits of periodontal microsurgery may include more foreseeable results, less invasive procedures with reduced patient discomfort, quick healing, improved esthetics, and greater patient compliance [32, 33]. The use of microsurgical principles and techniques has been applied to flap reflection and suturing that provides a great means of having accurate control of the gingiva without unduly traumatizing the tissue by stretching, distorting, or tearing it [34]. The use of microsurgery requires training and practice with the help of visual feedback rather than tactile feedback unlike macrosurgery [33]. It is an area of immense interest and practical application for the growth and future of periodontics [34]. With adequate training, surgical operating microscopes have shown great results for periodontists [7]. The use of magnification has enormous potential in enhancing the quality of dental hygiene, clinical care and the musculoskeletal health of dental hygienists [35]. Studies have shown that the implementation of magnification would help to decrease the incidence of musculoskeletal problems experienced

by dental hygienists [14]. Microscope and microsurgical techniques are excellent ways to maintain our passion for a more demanding profession [36].

5. Use of Magnification Devices in Prosthodontics Practice

In Prosthodontics using a surgical operating microscope, or high magnification like 6-8x or greater binocular surgical loupes telescopes, along with co-axial illumination will help to detect a preliminary path of placement for an arch for removable partial denture and reduce long-term periodontal or structural damage to abutment teeth [37].

6. Use of Magnification Devices in Oral Surgery Practice

Endoscopy is rapidly gaining importance in the field of Oral and maxillofacial surgery [38]. The utilization of multiple visual and standard instruments such as laparoscopic devices, endoscopic instruments, and high-powered magnification devices have helped clinicians to reduce the morbidity of surgical procedures by avoiding the need for a large surgical incision. Minimally invasive approaches have evolved through the development of surgical microscopes equipped with a camera to obtain visual images for maxillofacial surgeries. Minimally invasive techniques will decrease complications in the reconstruction of facial fractures through smaller incisions and less extensive exposure [39]. Trauma, maxillary sinus, orthognathic, salivary ductal system, and temporomandibular joint surgery are commonly performed with the help of the endoscope [39]. Surgical anatomy and various other principles can easily be taught to trainees with the help of the endoscope at academic institutions. The operating surgeon can visualize an area through the endoscope, and instruct regarding the surgical maneuvers on the

monitor, without obstructing the view [40, 41]. This technique will allow other persons in and out of the room to view the image. Endoscopically assisted surgery is a great tool frequently used by surgeons to assist in and simplify techniques that may require more extensive surgical exposure for visualization [39].

7. Selection of Magnification Devices

Improperly selected or adjusted surgical magnification systems can promote postures that place clinicians at increased risk for musculoskeletal problems. Clinicians must first establish the optimal working position that benefits their musculoskeletal health and then select the magnification systems that will support the position [11]. Working distance along with the depth of field and optical declination angle of the selected system must address the musculoskeletal needs of the clinician [35, 42]. A Routinely used Galilean loupes, of either 2.6x or 3.25x, provide a good compromise of working distance, field of view, depth of focus, cost and comfort to begin with [15]. A Clinicians Report survey of over 1600 clinicians among which over 90% used loupes found that the majority of those dentists recommended a longer working distance with the most common being 18 inches. A declination angle of greater than 35 degrees, a head tilt angle of lesser than 25 degrees and a higher magnification was recommended by experts for better ergonomics [44]. The angle of convergence of the two eyepieces must be equal to eliminate fatigue and headaches. It will also ensure the reduction of eye strain to avoid double vision. Improper selection can lead to a shorter attention span during clinical work. High prevalence of co axial misalignment among surgical loupes used by dental professionals was noted [45]. Denture work, orthodontics, and shade matching are few areas in which the use of magnification will have very of little or no benefit [43]. Choosing and

purchasing a microscope involves a great number of factors, including the efficiency of one's current vision, the nature of practice, the keenness on one's quality of his or her dentistry, the amount of time and expense one is willing to dedicate at becoming competent in using magnification. In addition, one must acquaint oneself with the various levels of magnification offered, various depths, and widths of field to meet their normal practice needs, the amount of space required for the equipment, and the cost-effectiveness of the investment [24]. Some of the reported drawbacks are adjustment period to the new working environment, their high cost, additional protocols for infection control, as well as a possible injury at the workplace.

8. Conclusion

The use of magnification in dentistry has been continuously gaining momentum and loupes are the most popular magnification devices in use. Along with a promise of enhanced vision they provide a valuable ergonomic advantage thus promoting long term health of the clinicians. Compound and prismatic telescopic loupes are superior choices compared to simple diopter lenses. Magnification would surely become the standard of care in dentistry in the near future. The long-term benefits of the use of magnification in dentistry outweigh the minor shortcomings. It would benefit the dental community if dental magnification by way of loupes is introduced to dental students at dental schools and if more dental schools around the world embrace the concept of magnification thus promoting ergonomic dental practice. Practicing clinicians that have graduated prior should try to incorporate magnification into their clinical practice by low magnification loupes to discover the benefits of enhanced precision and an improved quality of life by reducing the undue stress on musculoskeletal system.

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