Enhanced Visualization in Periodontal Therapy: A Clear Picture of Better Patient Care

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Short Description

Enhanced Visualization in Periodontal Therapy: A Clear Picture of Better Patient Care is a free dental continuing education course that covers a wide range of topics relevant to the oral healthcare professional community.

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Overview

Enhancing visualization within the oral cavity has long been a goal of dental practitioners. External lighting sources, patient positioning, and the use of mirrors have been employed since the onset of modern dentistry. However, as the complexity of dental and oral surgical procedures increases and as more advanced magnification tools become available, the adoption of tools to improve visualization has become more and more commonplace. Modern magnification and visualization aids can be utilized to improve clinical outcomes, enhance dental healthcare providers comfort and productivity, and improve the post-operative healing after periodontal procedures. Magnification loupes, microscopes, and enhanced visualization through the use of endoscopic visualization have been associated with enhanced outcomes of most technical dental procedures.[1,2] Given the importance of mere millimeters of hard and soft tissue in periodontal regenerative procedures and the challenges with adequate root debridement in closed scaling and root planing, it has been proposed that the use of enhanced visualization techniques are uniquely suited to improve nonsurgical and surgical periodontal procedures. This course seeks to review currently available technologies to enhance visualization and their applications and limitations for periodontal care.

Learning Objectives

Upon completion of this course, the dental professional should be able to:

- List currently available enhanced visualization technologies available for use in periodontal therapy.
- Understand the role of enhanced visualization in implementing minimally invasive and microsurgical techniques.
- Discuss the advantages and disadvantages of individual technologies to enhance visualization for use in periodontal therapy.
- Develop an understanding of patient- and procedure-based factors that may influence the optimal enhanced visualization techniques in periodontal therapy.

Introduction

Periodontitis is a common chronic infectious-inflammatory condition.[3] The primary etiology of periodontitis is dental plaque biofilm and bacterial-associated virulence factors.[4-6] These factors initiate a host immune response that results in the destruction of the hard and soft tissues supporting the teeth, this response is moderated by genetic, environmental, and acquired risk factors.[4-6] Initial periodontal treatment focuses on the effective and regular removal of the dental plaque biofilm and any secondary plaque retentive factors, such as dental calculus as well as host modulation and risk reduction strategies for periodontal disease modifying factors.[4-6] Adequate removal of primary etiologic factors is critical to achieving optimal periodontal health.[4-9] The long-term outcome of periodontal therapy, both nonsurgical and surgical, relies upon removal of the biofilm and elimination of periodontal pathogens associated with the tooth surfaces, periodontal tissues, mucosal surfaces, the tongue dorsum, and other niches within the oral cavity as well as the prevention of re-infection by exogenous and endogenous pathogens.[4,6] Nonsurgical periodontal therapy aims to establish a root surface that is biologically acceptable for the reestablishment of a healthy periodontal attachment,[10-13] but this can be a challenge in areas where visualization cannot be reliably achieved and access for debridement is limited. These areas may include deep periodontal pockets, root flutes, root concavities or other anatomic limitations, and the cemento-enamel junction (CEJ).[14-17] It is well-established that surgical flap reflection to allow for enhanced visualization improves the efficacy of root surface debridement and may account for improved clinical outcomes after surgical treatment at some sites.[18] While surgical debridement may improve biofilm and calculus removal, there are limitations and adverse outcomes of periodontal surgery in some instances. Increased gingival recession and esthetic compromise as well as post-operative discomfort and dentinal hypersensitivity (DH) are all common sequelae after periodontal surgery.[19] To reduce morbidity associated with surgical interventions and improve the outcomes of nonsurgical periodontal therapy many therapies have been proposed for use in practice, including the use of laser-assisted periodontal debridement, subgingival irrigations, local delivery of antimicrobial therapies, and enhanced visualization techniques. Specifically, enhanced visualization techniques, including the use of loupe magnification, microscopy, and periodontal endoscopy have been proposed as methods to avoid or limit surgical access in certain clinical scenarios. In addition, surgical techniques may be employed to repair defects caused by periodontal disease progression and acquired or innate mucogingival deformities. This course will review the adjunctive use of enhanced visualization protocols during the treatment of periodontal diseases and conditions.

Enhanced Visualization Technologies

Periodontal therapy aims to restore the periodontium to a state that allows for maintenance in health without clinical signs of inflammation or disease progression and to reestablish comfort, function, and esthetics.[20] Nonsurgical therapy includes the control of both primary and secondary etiologic factors. The removal of dysbiotic plaque biofilm, bacterial byproducts as well as plaque-retentive materials such as calculus, are critical to this treatment, paired with strategies to address secondary etiologic factors including systemic disease control, tobacco cessation/reduction, management of occlusal dysfunction, etc.[4-9] Scaling and root planing (ScRP) is a fundamental treatment for periodontitis.[10-13] The primary objective of ScRP is to restore periodontal health through removal of pathogenic products from periodontally-involved root surfaces to create biologically acceptable root surfaces.[10-13] These products, including plaque biofilm, calculus, and endotoxin, serve to induce host response and inflammation leading to attachment loss.[21] When performed adequately, ScRP results in significant reduction in probing depths, bleeding on probing, and subgingival dysbiotic biofilms, but limitations to ScRP efficacy exist.[13] It has also been noted that as calculus is a reservoir for live pathogens and bacterial endotoxins and thus incomplete calculus removal is associated with reinfection of the local subgingival environment and induce a recurrence of periodontitis.[14,15] Despite its widespread use as initial therapy for periodontitis, ScRP has rarely been found to achieve total calculus removal.[16] Furthermore, decreased effectiveness of ScRP has been associated with increased pocket depth, lack of visualization to access and identify residual deposits, instrumentation used, and operator experience.[16-19] Surgical access to allow for increased visualization has been shown to improve the efficiency of removal of deposits, but there are challenges and limitations to surgical therapy, including patient acceptance and potential post-operative esthetic compromise, patient discomfort, and healing times.[20-23] To increase the effectiveness of nonsurgical therapy, the use of enhanced visualization techniques, including the use of magnification loupes, periodontal endoscope, and microscopy have been proposed to enhance visualization and combat operator fatigue.

While the use of magnification in dentistry has occurred over the last few decades, the history of magnification stretches far back into history. It has long been proposed that magnification enjoyed widespread use throughout antiquity. The so-called Nimrud lens is a rock crystal artifact dated to the 7th century BC which may or may not have been used as a magnifying glass, or a burning glass.[24] It is also believed that the first known description of magnification is that of simple glass meniscus lenses described in hieroglyphics Egypt over 2800 years ago.[25] Furthermore, dental plaque

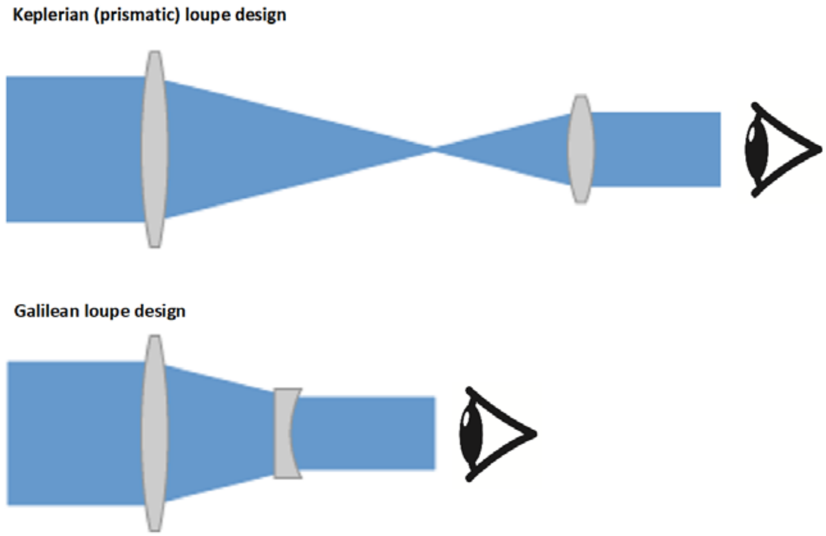

Figure 1. Galilean v. Keplerian (prismatic) lens design. Magnification loupes may be of either Galilean or Keplerian design.

observed under a microscope by Anton van Leeuwenhook in 1694 established the basis for microbiology.[26] The "animalcules" that van Leeuwenhook observed are also the primary etiological agents against which our current periodontal therapies are aimed. It is fitting, then, that current trends in periodontal diagnosis and treatment are incorporating these magnification techniques into more common use. An intact human eye with 20-20 visual acuity has the ability to differentiate between two distinct entities if they are at least 0.2mm apart from one another.[27] Dental healthcare professional should be aware of their own visual acuity and identify changes that may occur over time.[28]

Magnification

Enhancement of visual acuity through the use of magnification loupes is common in medicine and dentistry.[29] Loupes can provide magnification of 2 to 8x magnification and are used extensively during dental therapies, including nonsurgical and surgical periodontal therapies.[30] There are two general types of loupes that are used in dentistry: Galilean loupes and Keplerian (or prismatic) loupes.[30] Galilean loupes are composed up a set of lenses—a convex objective lens and a concave eyepiece lens. Galilean lenses generally have a magnification of 2-3x and offer depth and width of visual field that cannot be achieved with a single lens (i.e., simple loupe).[30] Keplerian loupes feature two or more positive convex lenses and can achieve magnification up to 8x.[30] Due to the number of lenses, Keplerian loupes tend to be heavier and offer a limited width of field, but newer materials, including high index, lightweight glass, can remedy these issues.[30]

Of the currently available enhanced visualization technologies, magnification loupes are the most used in dental practice. It has been reported that up to 66% of dentists utilize loupe magnification for some or all of the procedures that they perform, although a significantly lower percentage of dental hygienists reported loupe use.[31-33] The use of loupe magnification has demonstrated improved operator ergonomics, clinician comfort, and decreased incidence of musculoskeletal injury.[34-37] Furthermore, in novice dental and dental hygiene practitioners loupe use was associated with improved visual acuity.[38] It has also been suggested that loupe magnification may allow for enhanced visual acuity that can overcome age-related visual acuity loss associated with presbyopia in older dental practitioners.[39] Additionally, clinical outcomes after closed ScRP, including scanning electron tooth root surface roughness and inadvertent removal of cementum/root gouging were improved when 2.5x loupe magnification were used.[40] However, no such advantages to the use of loupe magnification were seen when they were used to improve visualization during supragingival scaling procedures.[41]

Microscopy for Nonsurgical Periodontal Therapy

Microscope use in medicine was pioneered by Carl Nylen at the University of Stockholm who developed a monocular microscope for ear surgery in 1922 and the first commercial binocular operating microscope in 1953 by the Carl Zeiss Company in West Germany.[42,43] Dental operating microscopes were introduced in 1978 and commercially produced in 1981 by Dentiscope (Chayes-Virginia, Inc. Evansville, IN).[44,45] Since that time, incorporation of dental operating microscopes into practice has adopted in many disciplines of dentistry. Generally, the surgical microscopes used in dentistry use Galilean optics.[46] They have binocular eyepieces joined by counteracting prisms creating a parallel optical axis.[46] The use of dental microscopy offers an ability to magnify areas that are extremely small and require precision to access and appropriately treat. Unlike loupe magnification, the dental microscope offers an ability to utilize different magnifications with the same instrument and can provide higher levels of magnification, generally up to 25x, although it has been reported that the ideal magnification for periodontal surgical procedures is generally reported to be 5-12x. While the use of dental microscopy is common in endodontic therapy, its adoption in periodontal therapies is less widespread.[47]

While microscope magnification is more commonly used in dentistry during endodontic and surgical interventions, microscopy use has been evaluated as a potential adjunctive visualization technique for closed scaling and root planing. Microsurgical approaches in periodontal therapy will be discussed later in this course. In studies evaluating the use of a surgical operating microscope at various magnification variables, it was demonstrated that probing depth reduction at 4 weeks was better for all variables than without magnification and that qualitative practitioner reports of improved ergonomics were best for 0.6 magnification variable (i.e. 3.5-5x magnification).[48] SEM analysis of extracted teeth that received no treatment, ScRP using loupe magnification, or ScRP with the use of a surgical operating microscope revealed that teeth treated with nonsurgical therapy with the use of the surgical operating microscope demonstrated less root gouging and more root surface nanohardness than those in other groups. Additionally, in vitro studies revealed improved attachment and proliferation of periodontal ligament cells and decreased pro-inflammatory cytokine production at the root surfaces treated with ScRP and microscope use.[48] This research indicates that the use of the surgical operating microscope may provide improved visualization leading to root surface biocompatibility and enhanced clinical outcomes.

Endoscopy

Endoscopy is a minimally invasive medical procedure allowing a physician to evaluate internal structures of the body through orifices

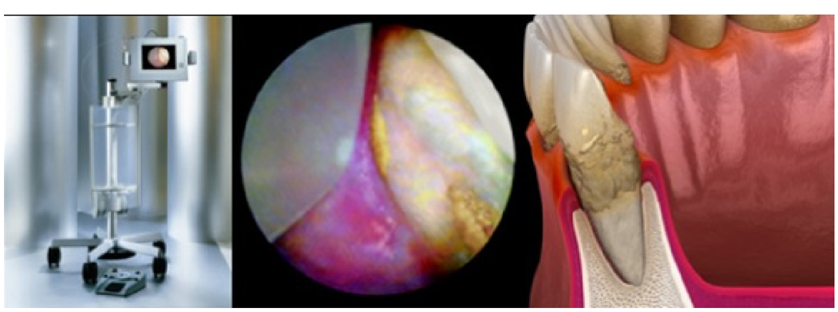

Figure 2. Visualization of subgingival calculus can be achieved with the periodontal endoscope.

or small surgical openings. Dental applications of endoscopy include visualization of the temporomandibular joint, maxillary sinus cavities, implant sites, endodontic evaluation of root canal areas, and to facilitate periodontal therapy.[49-53] Dental endoscopes are designed to provide subgingival visualization and consist of a thin fiber-optic cable comprised of bundles of thin glass fibers that are less than 1 mm in diameter. Dental endoscopes utilize the fiber-optic cable to transmit light to and from the area to be viewed and the images are viewed on a display screen.[54] When used subgingivally, the dental endoscope is used with internal irrigation and a sheath that provides a sterile barrier.[54] The dental endoscope provides magnification from 24-48x and is used with specialized probes, curettes, and retracting instruments to maximize visualization. The endoscope allows for real-time subgingival imaging with illumination and magnification.[54] Recent investigations across several research groups have demonstrated improved clinical outcomes at up to 12 months when the periodontal endoscope was used with scaling and root planing compared to scaling and root planing alone.[55-57] It should be noted that some of the differences seen were more pronounced in areas that may be more difficult to address with nonsurgical therapy, including deeper initial probing pocket depths (PD ≥ 5mm) and at multirooted teeth.[56,57] While further long-term controlled studies are required, it should be noted that histologic evidence of chronic inflammation and microscopic calculus root accretions were not found and/or were minimal at 6 months after ScRP with the use of the periodontal endoscope, which may indicate long-term benefits and/or a decreased likelihood for disease recurrence after the use of this visualization technology.[58]

Various randomized controlled studies have been performed to evaluate the use of the periodontal endoscope.[53-66] A recent systematic review and meta-analysis evaluating these reports concluded that the use of the periodontal endoscope could improve subgingival calculus removal when compared with ScRP alone.[52] However, clinical outcomes after ScRP with the use of a periodontal endoscope, including bleeding on probing (BOP), gingival index (GI), and probing depths (PD), did not demonstrate a statistically significant difference when compared to ScRP alone.[54] One explanation for these findings may be the relatively challenging and novel skills associated with use of the periodontal endoscope, including ambidextrous use of instrumentation, and the potential for a steep learning curve when adopting such a technology.[67] It has been suggested that a 2-4 week training period is necessary for mastery of the skills required to proficiently operate the periodontal endoscope.[68] Additionally, operator experience may influence the advantage provided by the use of periodontal endoscopy; in one preclinical investigation, no statistically significant difference was seen in simulated root surface deposit removal due to operator experience whereas operator experience did result in increased deposit removal without endoscope use.[69] There may also be anatomical limitations to the efficacy of a periodontal endoscope in clinical practice. Further, when applied in real-world clinical practice, the use of the periodontal endoscope is associated with an increase in treatment time and should be considered as a practical aspect of the clinical use of the periodontal endoscope.[53,54,56,68,69] For example, more time may need to be allotted to ScRP procedures when periodontal endoscopy is used as an adjunct and this may not align with remuneration associated with most fee schedules. There are no Current Dental Terminology (CDT) codes at this time that are associated with the adjunctive use of periodontal endoscopy during nonsurgical periodontal therapy,[70] which could also limit widespread adoption and no data currently exist on patient-centered outcomes and assessment of post-procedural comfort associated with the use of adjunctive periodontal endoscopy for visualization during ScRP. In many practices, a cost-utility analysis regarding the additional benefits that may be conferred with use of periodontal endoscopy weighed against the costs of increased instrumentation and upkeep and the time and training of dental healthcare professionals for the effective use of periodontal endoscopy.

The use of the periodontal endoscope has also been evaluated during periodontal surgery.

When endoscopic visualization was used during minimally invasive surgery, enhanced visualization was noted during surgery, but no differences in residual calculus were noted with or without endoscopic visualization at moderate to deep periodontal pockets.[71] It should also be noted that when nonsurgical therapy with the periodontal endoscope was compared to papilla preservation minimally invasive flap surgery, endoscopic nonsurgical therapy demonstrated reduced treatment time and non-inferior clinical outcomes compared to papilla preservation periodontal surgery.[72]

Advanced Visualization Techniques: Summary of Clinical Utility

The advantages and limitations of closed ScRP are well-established.[13,73] The removal of calculus and dental plaque biofilm with hand and ultrasonic scalers to achieve a biologically compatible root surface can result in significant clinical improvements.[13] Complete calculus removal can rarely be reliably achieved, decreased effectiveness in removal of root surface deposits has been associated with increasing probing depths and operator experience.[16,17] Because increased residual calculus after closed ScRP has been found within deeper periodontal pockets and at root flutes, tooth line angles, and at CEJ sites, these sites prove particularly challenging to achieve optimal clinical outcomes with only closed ScRP.[74,75] In these cases, increased visualization through surgical access has been demonstrated to improve the efficacy of calculus removal, but—even with surgical debridement—complete calculus removal at the scanning electron microscope (SEM) level is rare.[20] In addition to the challenges of calculus removal, detection of subgingival calculus deposits in a closed environment is also limited by a lack of visualization and inaccuracy of tactile sensations and potential confounding due to radicular irregularities, differentiation of the CEJ or restorative margins from calculus deposits, and variable subgingival anatomy.[76,77] In these cases, the use of enhanced visualization technologies have been proposed to improve the efficiency of nonsurgical periodontal therapies by allowing better visual assessment of exposed or subgingival root surfaces. Overall, the use of magnification has been associated with enhanced outcome of most technical dental procedures, including scaling and root planing.[1]

Minimally Invasive Periodontal Therapy with Surgical Microscopy (Microsurgery)

Microsurgery is defined as surgical procedures performed under a microscope using specialized instrumentation to allow for manipulation of small structures and to avoid interruption of adjacent tissues as much as possible. The procedures themselves are a mixture of surgical science and art and can take many years of training to become proficient.[78] Carl Nylen is considered to be the father of microsurgery and designed the first binocular microscope for use in medicine in 1921.[29] While other surgeons adopted the use of microscopes during surgery, its usefulness in complex treatments at sites with a minute scale was clearly demonstrated with Jacobsen and Suarez achieved complete patency after suturing blood vessels of < 1 mm in diameter during surgical anastomosis[79] and surgical microscopes were first introduced to dentistry in 1978 by Apotherker and Jako.[44] Given the minute scale on which surgical procedures are performed in periodontics, the addition of microsurgical techniques has challenges and advantages.

Generally, the traits associated with use of surgical stereomicroscopes are threefold: illumination, magnification, and increased precision in surgical skill delivery.[80] Illumination and magnification delivered by an external stereomicroscope offers the advantage that it allows significantly greater magnification when compared to loupes and the ability to deliver illumination directly to the surgical field. Unlike the use of the endoscope, minimally invasive surgical techniques with the use of surgical microscopy require elevation of gingival flaps to expose the working field, but this approach can allow for the utilization of minimal flap elevation and thus yield decreased post-operative healing time and discomfort. Lastly, due to the factors of magnification (generally between 5-12x for periodontal surgery) and the more delicate tissue manipulation, the use of microsurgical instrumentation and fine-gauge sutures are also a critical part of the armamentarium for periodontal microsurgery. The use of microsurgical instruments, such as ophthalmic knives, allows for small size and higher levels of precision and sharpness due to their method of preparation.[80] These factors, in turn, lead to a more even and exact wound edge which can be repositioned for more rapid post-operative healing.[80] In particular, debridement of defects for hard and soft tissue regeneration and periodontal mucogingival and aesthetic surgeries have been described as benefitting from the use of microsurgical techniques.[81-86] In particular, the use of the operating microscope for a microsurgical approach reduced gingival recession when compared to conventional surgery.[87] Further, it has been reported that enhanced debridement with decreased granulomatous tissue remnants and favorable early soft tissue healing while achieving similar bone quality when used during alveolar ridge preservation prior to dental implant placement.[88]

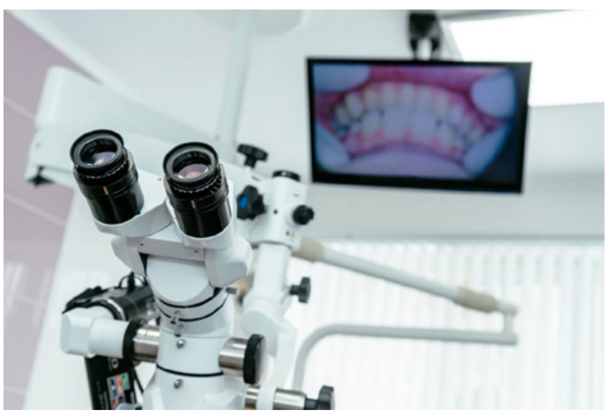

Figure 3. The use of a stereomicroscope to improve visualization during periodontal surgery

However, the limited field of view that is allowed via the stereomicroscope may limit the use of microsurgery for larger procedures and/or where depth perception is critical, such as dental implant placement.[81-84] While many of these reports are limited in nature, they should be critically evaluated and the benefit to clinical, aesthetic, and patient-reported outcomes thoroughly assessed.

This advanced armamentarium and the inevitable learning curve associated with acquiring new surgical skills may be a barrier to some practitioners, but can convey benefits for advanced surgical care including:[81-84]

1. Increased accuracy and decreased extent of incisions and flap elevation, which can decrease unintended surgical trauma and improve post-operative healing and patient-perceived discomfort.
2. Enhanced observation of etiologic factors that may cause recurrent disease progression and the ability to be more meticulous in debridement of surgical sites to ensure improved surgical outcomes.
3. Improved visualization for surgical positioning of tissues, leading to more exacting outcomes after soft and hard tissue manipulation.
4. Decreased surgical manipulation and interruption of blood supply lessens the risk of tissue injury and necrosis and functional and esthetic compromise.
5. Facilitation of healing by primary rather than secondary intention, which decreases significant variability in treatment outcomes and reduces untoward surgical healing.

Impact of Enhanced Visualization Techniques and/or Microsurgery on Ergonomics

An advantage of magnification use during the delivery of dental care is the reduction in practitioner malposition resulting in poor ergonomic form and subsequent potential injury. Work-related musculoskeletal disorders are common among dentists due to the repetitive, forceful or prolonged exertions of the hands and prolonged awkward postures.[89] In fact, it has been reported that nearly 30% of dentists who retire early do so due to musculoskeletal disorders that make practicing difficult and/or uncomfortable.[90] Proper positioning and ergonomics in dentistry is critical to the efficient and effective delivery of dental care as well as the maintenance of high levels of clinical skill throughout the working life of the dental healthcare professional. Practitioner posture is considered critical to avoiding many work-related musculoskeletal injuries for dentists and the following recommendations on ideal posture have been made:[91]

- Always try to maintain an erect posture
- Use an adjustable chair with lumbar, thoracic and arm support
- Work with hands location close to the body, not extended
- Minimize excessive wrist movements
- Avoid excessive finger movements
- Alternate work positions between sitting and standing
- Adjust the height of the practitioner's chair and the patient's chair to a comfortable level
- Consider horizontal patient positioning
- Check the placement of the adjustable light

Given these recommendations, the use of magnification may be critical in helping dental healthcare professionals achieve optimal ergonomic posture.[92] In a survey deployed to dental healthcare providers, the use of magnification was reported to improve practitioner comfort in 89% of cases.[93] The use of loupes by dentists and dental hygienists have been associated with improved posture and a more neutral body position when fitted properly.[92, 94-96] Both the dental endoscope and dental microscope require the practitioner to focus in front of them. The endoscope provides visualization on the external screen and the fixed eyepieces of the operating microscope necessitate an erect, forward positioning. Furthermore, it should be noted that unlike loupes, which generally have converging optics, the optics of a microscope are parallel, which can reduce the need for eye accommodation and decrease eye strain over time and decrease ocular fatigue.[47]

Gaps In Our Current Knowledge

More robust long-term studies are required to fully identify clinical scenarios and patient characteristics wherein the use of enhanced visualization may result in improved clinical and aesthetic outcomes and/or decrease post-operative discomfort. Additionally, a cost-utility analysis for these technologies based upon the types of procedures performed and the needs of both patient and practitioner may yield information that dental healthcare providers can use when choosing the technology that may be applicable in individual clinical environments. Comprehensive assessment of the start-up and maintenance costs of enhanced visualization technologies and their impact on clinical outcomes may allow practitioners to weigh their investment and potential enhanced fees for their patients with clinical benefits. Further, assessment of patient preferences and post-operative healing and discomfort may also impact the decisions of practitioners to incorporate such technologies into their practices.

Finally, for dental healthcare practitioners, the use of enhanced visualization techniques may result in improved ergonomics and decreased practitioner injury throughout their careers. This, in turn, may yield better dexterity and longevity and decrease operator fatigue throughout the clinical day, positively impacting patient care access and clinical outcomes. These direct advantages to practitioners (and potential indirect advantages to patients) could be another rationale for the adoption of such technologies. If employment of enhanced visualization techniques allows for an individual to practice for longer hours without fatigue or discomfort and extends one's practice lifetime, the investment in such technologies may be beneficial for the enjoyment and longevity of the dental practitioner.

Summary

The use of magnification and enhanced visualization techniques during the provision of periodontal therapy may provide significant benefits to patients and practitioners. There are several barriers to utilization, including potential costs and training as well as the increased treatment time associated with some of these technologies. The advantages include improved visualization and clinical outcomes as well as decreased risk of musculoskeletal injury for practitioners. The ideal clinical scenarios for each enhanced visualization technology are yet to be not fully identified, but these techniques may be valuable to allow for patient education, self-appraisal, and improving outcomes in practice.

Course Test Preview

To receive Continuing Education credit for this course, you must complete the online test. Please go to: www.dentalcare.com/en-us/ce-courses/ce653/test

1. **Properly performed scaling and root planing (ScRP) results in significant clinical improvements, but limitations to the efficacy of ScRP exist. Which of the following is not an anatomical root location where dental healthcare practitioners are more likely to leave residual calculus after ScRP?**
   A. Below the interdental contact points
   B. At root flutes
   C. At the cemento-enamel junction
   D. At tooth line angles

2. **Galilean loupes are composed up a set of lenses—a convex objective lens and a concave eyepiece lens and generally can achieve magnification of ______x.**
   A. 1.5-2x
   B. 2-3x
   C. 3-5x
   D. 6-8x

3. **Keplerian loupes feature two or more _______________ lenses and can achieve magnification up to 8x. Keplerian loupes tend to be heavier and offer a limited width of field.**
   A. Positive concave
   B. Negative concave
   C. Positive convex
   D. Negative convex

4. **The binocular surgical microscopes used in dentistry generally utilize _________ optics.**
   A. Prismatic
   B. Keplerian
   C. Galilean
   D. Simple

5. **The fiber optic cable in the dental endoscope is compromised of bundles of thin glass fibers and is approximately ________ in diameter.**
   A. 0.25 mm
   B. 0.5 mm
   C. 1.0 mm
   D. 5 mm

6. **How much magnification can be achieved using the dental endoscope?**
   A. 5-10x
   B. 12-18x
   C. 20-28x
   D. 24-48x

7. It has been reported that up to _____% of dentists utilize loupe magnification for some or all of the procedures that they perform.

A. 35%
B. 55%
C. 66%
D. 75%

8. With the use of 2.5x loupe magnification, ________ scaling outcomes, including decreased root surface roughness and reduced root gouging were noted. No difference was noted when 2.5x loupe magnification was used for __________ scaling.

A. Supragingival; subgingival
B. Subgingival; supragingival
C. Subgingival; intrasurgical
D. Intrasurgical; supragingival

9. Scaling and root planing with the use of a surgical operating microscope has demonstrated all the following compared with ScRP without magnification EXCEPT one. Which one is the exception?

A. Increased root surface hardness
B. Decreased root surface gouging as judged with scanning electronic microscopy (SEM)
C. Improved in attachment and proliferation of periodontal ligament cells
D. Increased pro-inflammatory cytokine production

10. The use of the periodontal endoscope when performing scaling and root planing has shown all the following clinical effects EXCEPT one. Which one is the exception?

A. Improved BOP when compared with ScRP alone
B. Enhanced subgingival calculus removal when compared with ScRP alone
C. No statistically significant changes in gingival index (GI) when compared to ScRP alone
D. No statistically significant changes in probing depths (PD) when compared to ScRP alone

11. A training period of ____________ has been recommended to achieve proficiency to operate the periodontal endoscope and overcome the steep learning curve.

A. 1 week
B. 2-4 weeks
C. 3 months
D. 1 year

12. The use of surgical microscopes was first introduced to dentistry in ____ by Apotherker and Jako.

A. 1965
B. 1972
C. 1978
D. 1986

13. Microsurgery REQUIRES all the following EXCEPT one. Which one is the exception?

A. Illumination
B. Magnification
C. Use of the periodontal endoscope
D. Increased precision in surgical skill delivery

14. Advantages of periodontal microsurgery includes all the following EXCEPT one. Which one is the exception?
A. Microsurgery allows for decreased extent of incisions and flap elevation
B. Improved surgical positioning of tissues due to enhanced visualization
C. Decreased healing time and post-operative discomfort.
D. Increased likelihood of healing by secondary rather than primary intention

15. During periodontal therapy, the use of microsurgery has been identified as advantageous in the following procedures EXCEPT one. Which one is the exception?
A. Debridement of defects for hard tissue regeneration
B. Dental implant placement
C. Mucogingival surgery
D. Aesthetic and/or periodontal plastic surgical procedures

16. Approximately ________% of dentists who retire early do so due to musculoskeletal disorders that make practicing difficult and/or uncomfortable.
A. 10
B. 20
C. 30
D. 50

17. The ergonomic impact of enhanced visualization on dental healthcare practitioners includes all the following EXCEPT one. Which one is the exception?
A. Reduction of repetitive hand movements
B. Improved practitioner comfort
C. Enhanced posture and a more neutral body position during patient care
D. Decreased eye fatigue

References

1. Campbell D. Magnification a major aid to dentists...and now microdentistry's time has come! *Future Dent* 1989; 4: 11.
2. Kwan JY, Newkirk S. Applications and limitations of periodontal endoscopy. An examination of the use of this technique in nonsurgical periodontal therapy. *Decisions in Dentistry*. 2016; 2(08): 10-14. Accessed November 22, 2021
3. Eke PI, Thorton-Evans GO, Wei L, Borgnakke WS, Dye BA, Genco RJ. Periodontitis in US Adults. National Health and Nutrition Examination Survey. 2009-2014.* J Am Dent Assoc* 2018; 149(7): 576-588.
4. Listgarten MA. Pathogenesis of periodontitis. *J Clin Periodontol* 1986; 13(5): 418-425.
5. Curtis MS, Diaz PI, Van Dyke TE. The role of microbiota in periodontal disease. *Periodontol 2000* 2020; 83(1): 14-25.
6. Meyle J, Chapple I. Molecular aspects of the pathogenesis of periodontitis. *Periodontol 2000* 2015; 69(1): 7-17.
7. Page RC. Schroeder HE. Pathogenesis of inflammatory periodontal disease. A summary of current work. *Lab Invest* 1976; 34: 235-249
8. Socransky SS, Haffajee AD. Current concepts of bacterial etiology. *J Periodontol* 1992; 63: 322-331.
9. Offenbacher S, Collins JG, Arnold RR. New clinical diagnostic strategies based on pathogenesis of disease. *J Periodontal Res* 1993; 28: 523-535.
10. Aleo JJ, De Renzis FA, Farber PA. The presence and biological activity of cementum-bound endotoxin. *J Periodontol *1991; 18: 160-170.
11. Gernett JS. Root planing: A perspective. *J Periodontol *1977; 48: 553-557.
12. O'Leary TJ. The impact of research on scaling and root planing. *J Periodontol* 1986; 57: 69-75.
13. Greenstein G. Periodotnal response to mechanical and non-surgical therapy. A review. *J Periodontol* 1992; 63: 118-130.
14. Nyman S, Westfelt E, Sarhed G, Karring T. Role of diseased root cementum in healing following treatment of periodontal disease. A clinical study.* J Clin Periodontol*. 1988;15:464–468.
15. Mandel ID. Calculus update: prevalence, pathogenicity and prevention. *J Am Dent Assoc*. 1995;126:573–580.
16. Rabbani GM, Ash MM Jr., Caffesse RG. The effectiveness of subgingival scaling and root planing in calculus removal. *J Periodontol* 1981; 52: 119-123.
17. Sherman PR, Hutchens LH Jr, Jewson LG, et al. The effectiveness of subgingival scaling and root planning. I. Clinical detection of residual calculus. *J Periodontol*. 1990;61(1):3-8.
18. Waerhaug J. Healing of the dento-epithelial junction following subgingival plaque control. II: As observed on extracted teeth. *J Periodontol.* 1978;49(3):119-134.
19. Bower RC. Furcation morphology relative to periodontal treatment. Furcation entrance architecture. *J Periodontol.* 1979;50(1):23-27
20. Caffesse RG, Sweeney PL, Smith BA. Scaling and root planing with and without periodontal flap surgery. *J Clin Periodontol* 1986; 13: 205-210.
21. Nesbit SP, Reside J, Moretti A, Gerdts G, Boushell LW, Barrero C. "Definitive Phase of Treatment" *Diagnosis and Treatment Planning in Dentsitry (Third Ed)*. 2017.
22. American Academy of Periodontology. Guidelines for periodontal therapy (position paper)* J Periodontol* 2001; 72: 1624-1628.
23. Jones W, O'Leary TJ. The effectiveness of in vivo root planing in removing bacterial endotoxin from the roots of periodontally involved teeth.* J Periodontol* 1978; 49: 337-342.
24. Brewster D. "On an account of a rock-crystal lens and decomposed glass found in Niniveh." Die Fortschritte der Physik (in German). Deutsche Physikalische Gesellschaft. 1852; p. 355.
25. Kriss TC.; Kriss, Vesna Martich. "History of the Operating Microscope: From Magnifying Glass to Microneurosurgery". *Neurosurgery*. 1998; 42(4): 899–907.
26. Pommerville J. *Fundamentals of microbiology*. Burlington, MA: Eds. Jones and Barlett Learning. 2014; p. 6.

27. Bud MG, Pop OD, Cimpean S. Benefits of using magnification in dental specialties—a narrative review. Medicine and Pharmacy Reports. 2023; 96(3): 254-257.
28. Eichenberger M, Perrin P, Neuhaus KW, Bringolf U, Lussi A. Influence of loupes and age on the near visual acuity of practicing dentists. J Biomed Opt 2011; 16: 035003.
29. Low JF, Dom TNM, Baharin SA. Magnification in endodontics: A review of its application and acceptance among dental practitioners. *Eur J Dent*. 2018; 12(4): 610-616.
30. James T, Gilmour ASM. Magnifying loupes in modern dental practice: An update. *Dental Update*. 2010; 37: 633-636.
31. Alhazzazi TY, Alzebiani NA, Alotaibi SK, et al. Awareness and attitude toward using dental magnification among dental students and residents at King Abdulaziz University, Faculty of Dentistry. *BMC Oral Health*. 2016; 17(1): 21.
32. Aboalshamat K, Daoud O, Mahmoud LA, et al. Practices and Attitudes of Dental Loupes and Their Relationship to Musculoskeletal Disorders among Dental Practitioners. *Int J Dent*. 2020; 2020: 8828709.
33. Congdon LM, Tolle SL, Darby M. Magnification loupes in U.S. entry-level dental hygiene programs--occupational health and safety. *J Dent Hyg.* 2012; 86(3): 215-222.
34. Aghilinejad M, Kabir-Mokamelkhah E, Talebi A, Soleimani R, Dehghan N. The effect of magnification lenses on reducing musculoskeletal discomfort among dentists. *Med J Islam Repub Iran*. 2016;30:473. Published 2016 Dec 28.
35. Maillet JP, Millar AM, Burke JM, Maillet MA, Maillet WA, Neish NR. Effect of magnification loupes on dental hygiene student posture. *J Dent Educ*. 2008; 72(1): 33-44
36. Hayes MJ, Osmotherly PG, Taylor JA, Smith DR, Ho A. The effect of wearing loupes on upper extremity musculoskeletal disorders among dental hygienists. *Int J Dent Hyg.* 2014; 12(3): 174-179.
37. Wajngarten D, Garcia PPNS. Effect of magnification devices on dental students' visual acuity. *PLoS One*. 2019; 14(3): e0212793.
38. Perrin P, Eichenberger M, Neuhaus KW, Lussi A. Visual acuity and magnification devices in dentistry. *Swiss Dent J*. 2016; 126(3): 222-235.
39. Dadwal A, Kaur R, Jindal V, Jain A, Mahajan A, Goel A. Comparative evaluation of manual scaling and root planing with or without magnification loupes using scanning electron microscope: A pilot study. *J Ind Soc Periodontol* 2018; 22(4): 317.
40. Corbella S, Taschieri S, Cavalli N, Francetti L. Comparative evaluation of the use of magnification loupes in supragingival scaling procedures. *J Invest Clin Dent* 2018; 9: e12315.
41. Penmetsa G, Panda K, Manthena A, Korukonda R, Gadde P. Evaluating the efficacy of different magnification variables during root planing procedure under a surgical operating microscope in chronic periodontitis: A randomized clinical trial.* J Ind Soc Periodontol *2020; 24(1): 32.
42. Dohlman CF. Carl Olaf Nylen and the birth of the otomicroscope and microsurgery. *Arch Otolaryngol *1969; 90: 813-817.
43. Hoerenz P. The design of the surgical microscope: Part 1 Ophthalmic Surg 1974; 4: 40-45.
44. Apotheker H, Jako GJ. A microscope for use in dentistry. *J Microsurg* 1981; 3: 7-10.
45. Apotheker H. The application of the dental microscope: preliminary report *J Microsurg* 1981; 3: 103-106.
46. Mallikarjun SA, Devi PR, Naik AR, Tiwan S. Magnification in dental practice: How useful is it? *J Health Res Rev* 2015; 2: 39-44.
47. Sitbon Y, Attathom T. Minimal intervention dentistry II: part 6. Microscope and microsurgical techniques in periodontics. Br Dent J 2014; 216: 503-509.
48. Liao H, Zhang H, Xiang J, Chen G, Cao Z. The effect of the surgical microscope on the outcome of root scaling. *Am J Transl *Res 2020; 12(11) 7199-7210.
49. Caris FR, von Hochstetter A, Makek M, Engeike W. Diagnostic accuracy of TMJ arthroscopy in correlation to histological findings.* J Craniomaxillofac Surg* 1995; 23: 75-80.
50. Engelke W, Schwarzwaller W, Behnsen A, Jacobs HG. *Suantroscopic laterobasal* sinus floor augmentation (SALSA): An up-to-5-year clinical study. *Int J Oral Maxillofac Implants* 2003; 18: 135-143.

51. Engelke WGH. In situ examination of implant sites with support immersion endoscopy. *Int J Oral Maxillofac* Implants 2002; 17: 703-706.
52. Engelke W, Leiva C, Wagner G, Beltran V. In vitro visualization of human endodontic structures using endoscope systems. Int J Clin Exp Med 2015; 8(3): 3234-3240.
53. Geisinger ML, Mealey BL, Schoolfield J, Mellonig JT. The effectiveness of subgingival scaling and root planing: An evaluation of therapy with and without the use of the periodontal endoscope. J Periodontol 2007; 78: 22-28.
54. Kuang Y, Chen J, Feng G, Song J. Effects of periodontal endoscopy on the treatment of periodontitis. *J Am Dent Assoc *2017; 148: 750-758.
55. Naicker M, Ngo LH, Rosenberg AJ, Darby IB. The effectiveness of using the perioscope as an adjunct to non-surgical periodontal therapy: Clinical and radiographic results. J Periodontol 2022; 93: 20-30.
56. Wu J, Lin L, Xiao J, Zhao J, Wang N, Zhao X, Tan B. Efficacy of scaling and root planing with periodontal endoscopy for residual pockets in the treatment of chronic periodontitis: a randomized controlled trial. Clin Oral Invest 2022; 25: 513-521.
57. Wright HN, Mayer ET, Lallier TE, Maney P. Utilization of a periodontal endoscope in nonsurgical periodontal therapy: A randomized, split-mouth clinical trial. J Periodontol 2023; 94: 933-943.
58. Kwan JY. Enhanced periodontal debridement with the use of micro ultrasonic, periodontal endoscope. *J Calif Dent Assoc* 2005; 33(3): 241-248. Erratum in *J Calif Dent Assoc* 2005; 33(4): 282.
59. Avradopoulos V, Wilder RS. Chichester S. Offenbacher S. Clinical and inflammatory evaluation of perioscopy on patients with chronic periodontitis. *J Dent Hyg* 2004; 78(1): 30-38.
60. Michaud RM, Schoolfield J, Mellonig JT, Mealey BL. The efficacy of subgingival calculus removal with endoscopy-aided scaling and root planing: a study on multi-rooted teeth. *J Periodontol* 2007; 78(12): 2238-2245.
61. Blue CM, Lenton P, Lunos S, Poppe K, Osborn J. A pilot study comparing the outcome of scaling and root planing with and without Perioscope™ technology.* J Dent Hyg* 2013; 87(3): 152-157.
62. Hu-Rui LL, Jia NL, Huang TH, et al. Effect of plaque and calculus removal by scaling and root planing with or without perioscope in chronic periodontitis. J Dent Prev Treatment 2013; 21(5): 261-264.
63. Hou Y. Comparison of the effect of periodontal scaling under the periodontal endoscope and traditional periodontal scaling on periodontitis. Chinese Journal of Practical Medicine 2016; 43(18): 68-70.
64. Liao YT, Liu Y, Jiang Y. Ouyang XY, He I, An N. A clinical evaluation of periodontal treatment effect using periodontal endoscope for patients with periodontitis: a smith mouth controlled study. *Zhonghua Kou Qiang Yi Xue Za Zu* 2106; 52(1): 722-727.
65. Zhou W. The application of periodontal endoscope to remove subgingival calculus. Health Res 2016; 36(3): 344-345.
66. Geisinger ML. Letters.* J Am Dent* Assoc. 2018 149(3): 170.
67. Stambaugh RV, Meyers G, Ebling W, Beckman B, Stambaugh K. Endoscropic visualization of the submarginal gingival dental sulcus and tooth root surfaces. *J Periodontol* 2002; 73(4): 374-382.
68. Graetz C, Schorr S, Christofzik D, Dörfer C, Sälzer S. How to train periodontal endoscopy? Results of a pilot study removing simulated hard deposits *in vitro. Clin Oral Invest* 2020; 24: 607-617.
69. Wilson Jr. TG, Carnio J, Schenk R, Myers G. Absence of histologic signs of chronic inflammation following closed subgingival scaling and root planing using the dental endoscope: human biopsies—a pilot study.* J Periodontol *2008; 79(11): 2036-2041.
70. American Dental Association. CDT 2021: Current Dental Terminology.
71. Dunegan KA, Deas DE, Powell CA, Ruparel NB, Kotsakis GA, Mealey BL. Subgingival scaling and root planing during minimally invasive periodontal surgery: A randomized controlled split-mouth trial. J Periodontol 2024; 95: 9-16.

72. Ho KLD, Ho KLR, Pelekos G, Leung WK, Tonetti MS. Endoscropic re-instrumentation of intrabony defect-associated deep residual periodontal pockets is non-inferior to papilla preservation flap surgery: A randomized trial. J Clin Periodontol 2024; 0: 1-10.
73. Kepic TJ, O'Leary TJ, Kafrawy AH. Total calculus removal: an attainable objective? *J Periodontol*. 1990; 61(1):16-20.
74. Brayer WK, Mellonig JT, Dunlap RM, Merinak KW, Carson RE. Scaling and root planing effectiveness: The effect of root surface access and operator experience. *J Periodontol *1989; 60: 67-72.
75. Hallmon WW, Rees TD. Local anti-infective therapy: mechanical and physical approaches. A systematic review. Ann Periodontol. 2003; 8: 99-114.
76. Eaton KA, Kaiser JB, Davies RM. The removal of root surface deposits. *J Clin Periodontol* 1985; 12: 141-152.
77. Sherman PR, Hutchens Jr. LH, Jewson LG, Moriarity JM, Greco GW, McFall Jr. WT. The Effectiveness of Subgingival Scaling and Root Planing I. Clinical Detection of Residual Calculus. *J Periodontol* 1990; 61: 3-8.
78. American Society of Plastic Surgeons. "What is Microsurgery". Accessed November 22, 2021
79. Lee S, Frank DH, Choi SY. Historical review of small and microvascular vessel surgery. *Ann Plast Surg* 1983; 11: 53-62.
80. Belcher JM. A perspective on periodontal microsurgery. *Int**J Periodont* Rest Dent 2001; 21(2): 191-196.
81. Cairo F, Carnevale G, Billi M, Pini-Prato G, Fibre retention and papilla preservation technique in the treatment of intrabony defects: a microsurgical approach. *Int J Periodont Rest Dent *2008;28: 257-263.
82. Cortellini P, Tonetti MS. Microsurgical approach to periodontal regeneration: initial evaluation in a case cohort. *J Periodontol 2001*; 72: 559-569.
83. Shanelec DA. Periodontal microsurgery.* J Esthet Rest Dent* 2003; 15(Spec Iss): S118-S123.
84. Hegde R, Sumanth S, Padhye A. Microscope-enhanced periodontal therapy: a review and report of four cases. *J Contemp Dent Pract* 2009; 10(5): E088-96.
85. Chiang YC, Sirinirund B, Rodriguez A, Velasquez D, Chan HL. Operating microscope-assisted reconstructive strategies for peri-implantitis: A case series report. Clin Adv Periodontics 2024; 14: 149-156.
86. Sabri H, Alhachache S, Saxena P, Dubley P, Nava P, Rufai SH, Sarkarat F. Microsurgery in periodontics and oral implantology: a systematic review of current clinical applications and outcomes. Evid Based Dent June 12 2024 [Epub Online]
87. Rathore P, Manjunath S, Singh R. Evaluating and comparing the efficacy of the microsurgical approach and the convention approach for the periodontal flap surgical procedure: A randomized controlled trial. Dent Med Prob 2024; 61(1): 23-28.
88. Sirinirund B, Zalucha J, Betancourt ABR, Kripfgans OD, Wang CW, Velasquez D, Chan HL. Clinical outcomes of using operating microscope for alveolar ridge preservation: A randomized controlled trial. J Periodontol 2024; Oct 15 [Epub Ahead of Print]
89. Gupta A, Bhat M, Mohammed T, Bansal N, Gupta G. Ergonomics in dentistry.* Int J Clin Pediatr Dent*. 2014;7(1):30-34.
90. Murphy DC (NYU College of Dentistry, USA). Ergonomics and dentistry. *NY State Dent J.* 1997 Aug-Sep; 63(7): 30–34.
91. Chaikumarn M (Department of Human Work Sciences, Luleå University of Technology, Sweden. Differences in dentist's working postures when adopting proprioceptive derivation vs conventional concept.* Int J Occup Saf Ergon*. 2005; 11(4): 441–449.
92. Ludwig EA, et al. The effect of magnification loupes on dental hygienists' posture while exploring. *J Dent Hyg* 2017; 91(4): 46-52.
93. Aghilinejad M, Kabir-Mokamelkhah E, Talebi A, Soleimani R, Dehghan N. The effect of magnification lenses on reducing musculoskeletal discomfort among dentists. *Med J Islam Repub Iran*. 2016; 30: 473.

94. Branson BG, Bray KK, Gadbury-Amyot C, et al. Effect of mangnification lenses on student operator posture. *J Dent Educ* 2004; 68(3): 384-389.
95. Syme SE, Fried JL, Strassler HE. Enhanced visualization using magnification systems. *J Dent Hyg* 1997; 71(5): 202-206.
96. Ludwig EA, McCombs GB, Tolle SL, Russel SM. *J Dent Hyg* 2017; 91(4): 46-52.

Additional Resources

- No Additional Resources Available

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