

## Videoscope visualization and videoscope-assisted minimally invasive surgery in dentistry: a narrative review

Videoscope and dentistry

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### Abstract

A variety of magnification systems are applied in the field of dentistry to facilitate surgical procedures in a limited area. The development of the videoscope device has been intended to overcome various disadvantages that occur during surgical operations. The purpose of this review is to discuss 1) the use of videoscope-assisted minimally invasive surgery in periodontology and 2) the usage of videoscope in dentistry. An electronic search of literature published in English was carried out by two reviewers. Although videoscope usage has been documented to result in favourable outcomes, particularly in periodontal minimally invasive surgeries, further well-designed studies are recommended to provide more robust evidence.

### Keywords

anatomy, calculus, periodontal surgery, regeneration, root canal treatment

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## Introduction

In periodontics, minimally invasive surgery (MIS) was first described in 1995 to minimize surgical flap reflection, increase the patient's postoperative comfort, and achieve better clinical results in the regenerative treatment of periodontal intrabony defects.<sup>1</sup> Thereafter, variations in MIS techniques were described, such as minimally invasive surgery technique (MIST),<sup>2</sup> modified-MIST<sup>3</sup>, and entire papilla preservation technique.<sup>4</sup> In MIS techniques, the small flap is generally elevated with a single-surface approach utilizing different flap designs to position the periosteum approximately 1-2 mm apical to the coronal aspect of the alveolar bone and limit the number of sutures required following surgery.<sup>2-6</sup> Since indications for MIS techniques are primarily for the treatment of isolated interproximal periodontal intrabony defects, MIS procedures are usually completed with the use of graft materials and biomimetic agents such as enamel matrix derivate (EMD).<sup>7-8</sup> It has been reported that patient morbidity and discomfort are low while clinical success rates are high utilizing these techniques.<sup>3,9</sup> However, due to the size limitations associated with the flap design for MIS procedures, attempts have been made to improve surgical visualization with the help of devices such as dental loupes and flexible fiber optic endoscopes.<sup>2,10-13</sup> Moreover, magnification with a surgical microscope can limit surgical access and restrict visualization to a buccal approach, which places limitations on surgical flap design for all variations of MIS.

A review of the literature reported that the ideal imaging device for periodontal surgery is expected to be small enough to allow a very small surgical incision and to be able to provide direct visualization and easy maneuvering throughout the entire surgical field.<sup>13</sup> To increase visualization of the surgical field, the videoscope device utilizes a small camera with adjustable lighting, which can be placed into intra-bony defects utilizing either buccal or lingual elevated flaps.<sup>8</sup> The camera has a magnification value up to 40X, and utilizing its 2.7 mm carbon fiber retractor attachment, the camera can be easily rotated and adapted to most surgical fields.<sup>8</sup> AirShield® technology, a low-pressure air flow, is passed over the camera lens to ensure that direct surgical visualization is not blocked by blood, debris, and fogging [available at: <https://microsigthdental.com/wpcontent/themes/microSight/images/MicroSight-Datasheet-201910.pdf>].

Limited studies/case reports utilizing this technique/technology have been published. The purpose of this narrative review is to discuss the literature published to date regarding videoscope-assisted minimally invasive surgery (VMIS) and the use of videoscope in dentistry.

## Materials and Methods

Due to the design and presentation of this study as a narrative review, there is no need for ethics committee approval.

### Focused Question

What are the clinical outcomes when using the videoscope in periodontal regenerative surgery? Can the videoscope device be used in other branches of dentistry?

## Information Sources

An electronic search of literature published in English between January 1977 and June 2024 was carried out by 2 reviewers (B.G.A and H.A) using PubMed, Google Scholar, Scopus, and the University of Illinois Chicago Library Database. Reference lists of studies were also hand-searched for relevance. The MeSH terms used for the search included 'videoscope' OR 'videoscope-assisted minimal invasive surgery' OR 'videoscope and dentistry'.

## Selection Criteria

Studies were included for the review if the following inclusion criteria were fulfilled: 1. Studies specific to the use of a videoscope in dentistry, 2. In vitro and in vivo studies relevant to videoscope in dentistry, and 3. Written in English. Videoscope methods used outside the field of dentistry, applications with other magnification devices used other than the videoscope device, and non-English literature were excluded from this study.

## Statistical Analysis

No statistical analysis was performed in this study because it is a narrative review based on previously published literature.

## Ethics Approval

Ethical approval was not required for this study because it is a narrative review and does not involve human participants or animal subjects.

## Reporting Guidelines

This manuscript was prepared and reported as a narrative review of the existing literature.

## Results

### Data Extraction Results

The following data were extracted from selected clinical studies: authors and year of publication, study design, number of patients and interproximal defects, age, surgical treatment type, biomaterial for regenerative treatment, the mean probing depth (PD), clinical attachment level (CAL) and gingival recession (GR) before treatment (T0) and last follow-up sessions (T1)(Table 1). As a result of the literature search, a total of 572 articles related to keywords were found. When the abstracts of the studies were evaluated, it was found that a total of 17 articles were related to the videoscope. Of these articles, two book chapters, four reviews, and two manuscripts related to forensic studies were excluded. A total of 9 articles were included for evaluation in this study. Evaluation of the risk of reporting bias is not performed because of the single randomized-controlled study.

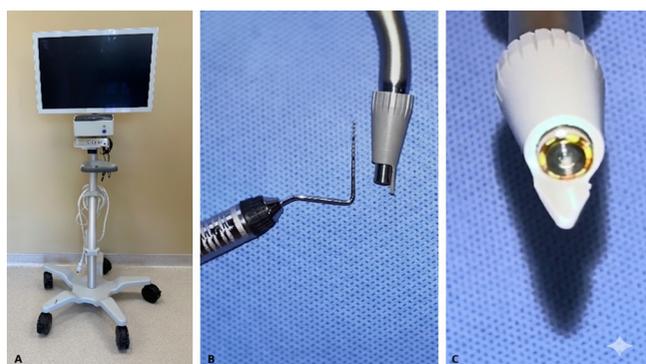
### Videoscope-Assisted Minimal Invasive Surgery Technique

The VMIS surgical technique was first presented in the literature in 2013.<sup>8</sup> This study provided proof of principle and introduced the device and surgical technique (Figure 1). VMIS utilizes the following criteria (1) a single small lingual flap design, (2) split thickness incisions, (3) avoiding the use of a periosteal elevator, (4) retaining the buccal papilla and esthetic

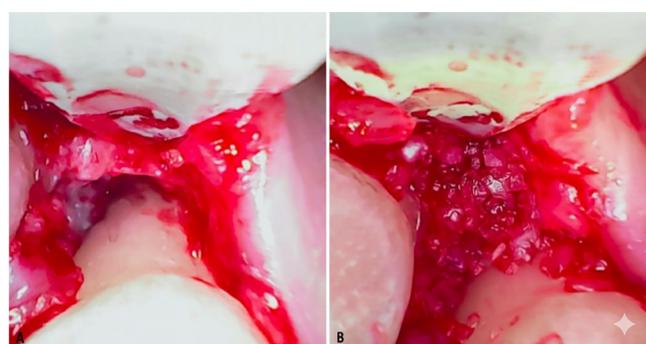
**Table 1.** Clinical Studies related to videoscope and videoscope-assisted minimal invasive surgery

Authors	Years	Study Design	Number of Patients	Number of Interproximal Defects		Mean Age±SD	Surgical Treatment Type	Biomaterial	Mean PD at T0	Mean PD at T1	CAL at T0	CAL at T1	GR at T0	GR at T1
Harrel SK et al. <sup>8</sup>	2013	Case Series	N/A	Single-walled	N/A	N/A	Regenerative	EMD and/or bone graft material	N/A	N/A	N/A	N/A	N/A	N/A
				Two- and three-walled	N/A				N/A	N/A	N/A	N/A	N/A	N/A
				Total	29				6.4±0.6	2.5±0.9	7.1±1.2	3.0±1.1	0.7±1.0	0.5±0.8
Harrel SK et al. <sup>17</sup>	2014	Prospective Cohort Clinical	30	One-walled	22	53.9±9.8	Regenerative	EMD and/or bone graft material	6.45±0.71	2.30±0.82	7.09±1.07	2.82±1.11	0.64±0.87	0.52±0.64
				Two- and three-walled	20				6.29±0.81	2.57±0.82	6.68±1.34	2.69±2.10	0.39±1.09	0.13±1.68
Harrel SK et al. <sup>18</sup>	2016	Cohort Clinical	18	One-walled	15	54.6±11.6	Regenerative	EMD and/or bone graft material	6.56±0.82	2.28±0.75	7.24±1.19	2.46±0.74	0.68±0.92	0.18±0.32
				Two- and three-walled	11				6.26±0.86	2.44±0.94	6.82±1.33	2.65±0.80	0.56±1.14	0.21±0.57
Harrel SK et al. <sup>19</sup>	2017	Prospective Cohort Clinical	14	One-walled	12	57	Regenerative	EMD and/or bone graft material	6.42±0.73	2.73±1.12	7.13±0.04	2.94±0.91	0.70±0.96	0.21±0.45
				Two- and three-walled	8				6.63±0.69	2.88±0.99	6.90±1.13	2.94±1.66	0.27±1.50	0.06±1.76
Wilson TG Jr. <sup>25</sup>	2018	Case Report	1	N/A	1	67	Regenerative	DFDBA mixed with EMD	10	<3	N/A	N/A	N/A	≈ 2
Dunegan KA et al. <sup>22</sup>	2024	RCT	13	N/A (Control)	44	N/A	SRP	N/A	N/A	N/A	N/A	N/A	N/A	N/A
				N/A (Test)	45				N/A	N/A	N/A	N/A	N/A	N/A

RCT: Randomized-Controlled Trial; SRP: Scaling and root planning; PD: Probing Depth; CAL: Clinical Attachment Level; GR: Gingival Recession; EMD: Enamel Matrix Derivate; DFDBA: Demineralized freeze-dried bone allograft; T0: Before treatment; T1: Last follow-up session; SD: Standard Deviation; N/A: Not Available



**Figure 1.** The images of A. Videoscope Device B. Videoscope camera tip C. Front view of videoscope camera tip



**Figure 2.** Videoscope images at periodontal regenerative surgery A. Three-wall periodontal defect view B. The image of periodontal defect filling with biomaterial

facial gingiva intact and unreflected whenever possible, and (5) simple suturing techniques avoiding passage of sutures through

the marginal tissue of the incision.<sup>14</sup> In the current protocol, amelogenins (Emdogain®, Straumann, Basel, Switzerland) and particulate bone allografts are utilized. If surgical incision was performed correctly, the facial papilla remains intact, and the videoscope retractor tip can be inserted into the defect without interference. Granulation tissues are removed, and deposits of calculus on the root surface are easily detected using the videoscope, permitting thorough mechanical root debridement due to the 20-40X magnification image projected onto a video display. Thereafter, 24% ethylenediaminetetraacetic acid (EDTA) is applied on the root surface, and the regenerative treatment of the intra-bony defect is completed with the application of EMD/graft material (Figure 2).<sup>8</sup> The use of EMD alone or in combination with bone particulate is common in other forms of minimal invasive surgeries.<sup>7-12</sup> However, a membrane cannot be applied using MIS due to the limited incisions and flap reflection.<sup>9,13</sup> Care must be taken not to overfill the defect with graft materials, which will prevent primary wound closure and likely result in graft material exposure to the oral environment.

**Periodontal Regenerative Surgery**

In the first case series published on VMIS, 29 intra-bony defects were evaluated. EMD was applied to all defects, and 6-month results were reported. A significant decrease in mean PD and mean CAL values without changes in mean GR compared to the baseline values was reported.<sup>8</sup> It is notable that studies on other MIS techniques emphasize that GR occurs, although at a minimum rate.<sup>12,15</sup>

A case series reported outcomes on systemically healthy patients with interproximal periodontal defects  $\geq 5$  mm, clinical attachment loss  $\geq 2$  mm, and bone loss detected radiographically after Phase-I treatment.<sup>16</sup> A total of 30 patients and 110 defects were included in the study, and intra-bony defects were classified according to the number of walls: 64 had one-wall defects, 44 had two-wall defects, and two had three-wall defects. PD, CAL, and GR values before and after treatment were recorded.<sup>16</sup> The VMIS protocol was used in all cases, including application of EDTA to the root surface, followed by application of EMD + cortical freeze-demineralized dried bone allograft into the intra-bony defect. At 6 months, PD and CAL values decreased significantly compared to the initial values in single-, two-, and three-walled defects, while no significant difference in GR was noted.<sup>16</sup> A follow-up study reported 12 month outcomes on the same patient cohort and included patient morbidity data and the analyzes performed on 18 patients and 26 defects, there was no significant difference in PD and CAL values between the 6 and 12 months in all patient groups while statistically significant differences were maintained to 12 months compared to baseline and no significant changes in GR were observed.<sup>17</sup> When postoperative pain was measured using a Visual analog scale (VAS), 1/30 (3.3%) reported a VAS value between 1 and 3 within the first two weeks post-surgery.<sup>17</sup> Moreover, 36-month results of the same patient cohort on 14 patients were reported. When changes between baseline to 36 months were evaluated, statistically significant differences in PD and CAL were maintained during the 3-year follow-up period, with no significant difference in GR values.<sup>18</sup>

#### **Detection of Root Surface Anomalies and Calculus with Videoscope**

The videoscope was used to determine the frequency of microgrooves associated with osseous defects in patients and dried skulls.<sup>19</sup> In vitro, 69 sites with vertical bone loss were identified and evaluated in 200 dried skulls using the videoscope. Using 66 consecutive videos takes from VMIS surgeries, 50 teeth (79%) were found to have microgrooves. The authors concluded that microgrooves may represent a risk factor for site-specific progression of periodontal destruction.<sup>19</sup> Significantly, the ability to visualize and magnify the surgical field using the videoscope played a large part in identifying the microgrooves, which would otherwise be difficult to detect using other forms of magnification.

Magnification of root surfaces during VMIS procedures identified small deposits of material resembling calculus, termed micro islands of calculus. To verify that these were indeed residual calculus deposits and if they can be removed with chelating agents, 22 teeth with heavy calculus were included in an ex vivo study using the videoscope. Following tooth extraction, one root surface per tooth was selected, and 5 mm<sup>2</sup> areas were marked for evaluation. A 655-nm diode laser was utilized for fluorescent detection of calculus. Digital images of the marked evaluation area were made using the videoscope.<sup>20</sup> After the removal of visible calculus using 3.5X surgical loops, ultrasonic scaler, and gracey curettes, the test area was burnished with EDTA

for 30 seconds, and imaging was repeated. Results indicated that micro islands of calculus remain on root surface after instrumentation using 3.5X magnification despite obtaining a visually “clean” surface. The study showed that there was a statistically significant difference in calculus deposits before and after the application of EDTA using both the videoscope and laser fluorescence imaging. Thus, the application of EDTA for 30 seconds after scaling and root planning (SRP) was useful in reducing or eliminating micro islands of calculus on tooth root surfaces.<sup>20</sup>

In a randomized-controlled, split-mouth clinical study, Dunegan et al. sought to determine if the videoscope can be used as a visual adjunct to SRP in combination with MIS.<sup>21</sup> Twenty-five pairs of periodontally hopeless teeth with PD  $\geq 5$  mm and heavy calculus scheduled for extraction were randomly assigned to either scaling and root planing with minimal surgical access using 3.5X surgical loupes (control) or the videoscope (test). In 89 interproximal areas evaluated, residual calculus ratio was visually detected in 2.61% and 2.71% of the control and test groups, respectively, with no significant difference observed.<sup>21</sup> The study confirmed a significant relationship between maximum PD and the percentage of calculus remaining on root surfaces. When the surgical duration was evaluated, a statistically significant difference was observed.<sup>21</sup>

#### **Peri-implantitis Treatment**

There is only one case report in the literature regarding the use of VMIS in the surgical treatment of peri-implantitis. In a 67-year-old healthy female patient, a PD value of 10+ mm was detected on a cemented-retained, tissue-level maxillary dental implant, which had been functional for 6 years. Following VMIS flap elevation, excess cement and granulation tissues were removed. A demineralized freeze-dried bone allograft with EMD was placed in the bone defect. At the one-year follow-up, PD was 3 mm, and GR was 2 mm, with improvements in radiographic outcomes noted.<sup>22</sup>

#### **The Use of the Videoscope in Endodontic Treatments**

A study compared dental operating microscope (DOM), surgical loupes, and high-resolution videoscope devices in terms of depth of field, resolution, effects on fine motor skills, and endodontist preference.<sup>23</sup> Results indicated that DOM showed significantly higher and better accuracy values than either the videoscope or surgical loupes. Residents achieved more acceptable results than dental students when using DOM or dental loupe. However, there was no significant difference between students and residents in the use of the videoscope. The shortest operation time was associated with surgical loupes, while the videoscope had the longest operating time. Survey results emphasized that using DOM was easier in terms of visualization, time efficiency, ergonomics, and orientation. This study noted that the most negative aspect of using the videoscope was related to hand fatigue and orientation.<sup>23</sup>

#### **Discussion**

The videoscope was patented and introduced in 2013<sup>8</sup>; however, a review of the literature noted very limited publications on this

topic. When clinical studies were evaluated, only one randomized controlled clinical study was found that specifically evaluated MIS treatment in periodontics but was aimed at evaluating residual calculus on extracted teeth and to determine if EDTA was useful in removing micro islands of calculus. No clinical measurements were presented.<sup>21</sup> As such, there is a need to conduct randomized-controlled clinical studies in which clinical, radiographic, and biochemical analysis of the effectiveness of VMIS treatment can be measured. In the literature, VMIS has generally been used with interproximal vertical defects, which may have created the notion that utilization of the videoscope and VMIS technique has a limited surgical indication. There is a need to evaluate the utility of this instrument in other periodontal/peri-implant procedures and indications.

The prevalence of peri-implantitis is increasing, and a systematic review reported that the prevalence was 12.53% in implant-based and 19.53% in patient-based cases.<sup>24</sup> The videoscope may be useful in the treatment of peri-implantitis, especially in evaluating the areas between implant threads using a minimally invasive approach. This stands as another area in need of further research.

### Limitations

Studies related to the VMIS technique evaluated a single graft material and/or EMD.<sup>8,16-18</sup> However, as a limitation, characteristics of the graft material and/or brand were not reported. Therefore, the application of different graft materials, such as putty or particulate biomaterials, with the VMIS technique should be evaluated in future studies. In endodontics, a study reported that endodontic surgery and retrograde approaches with dental operating microscopes were quite difficult in posterior teeth.<sup>25</sup> In cases where the field of view is narrow, the direct visualization feature of the videoscope and clear field of view may be an advantage.

The interpretation of non-invasive and invasive interventions and conservative and complicated interventions often depends on surgeon experiences.<sup>26</sup> Thus, very limited information can be obtained by only using VAS evaluation aspect of surgeon and patient's perceptions. The number of randomized controlled studies on the use of videoscopes in minimally invasive surgery and other related fields is relatively limited, and the results of these studies are often contradictory due to the lack of available data.

### Conclusion

Although MIS associated with the videoscope has been used successfully in different surgical applications in the clinic, the quality of the studies needs to be improved. Further research is necessary to reach a conclusion regarding the efficacy and safety of videoscopes. Large multicenter clinical studies using the videoscope and VMIS technique should include patient and clinician perception to go along with clinical and biological findings.

### Ethics Declarations

*This article is a narrative review of previously published studies and does not involve any new studies with human participants or animals performed by the authors.*

### Animal and Human Rights Statement

*This study did not involve human participants or animals. Therefore, ethical approval and compliance with institutional or national research committee standards were not required.*

### Informed Consent

*Informed consent was not required as this study does not include any individual patient data.*

### Data Availability

*No new data were generated or analyzed in this study. Data supporting this review are available within the cited references.*

### Conflict of Interest

*The authors declare that there is no conflict of interest regarding the publication of this article.*

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*None*

### Author Contributions (CRediT Taxonomy)

*Conceptualization: B.G.A., S.N.*

*Methodology: B.G.A., H.A.*

*Literature Search and Data Curation: B.G.A., H.A.*

*Writing – Original Draft Preparation: B.G.A.*

*Writing – Review & Editing: S.N., T.F.T.*

*Supervision: S.N., T.F.T.*

### Scientific Responsibility Statement

*The authors declare that they are responsible for the scientific content of this article, including its conception, design, literature evaluation, interpretation of findings, drafting, revision, and final approval of the manuscript.*

### Abbreviations

*CAL: Clinical Attachment Level*

*DOM: Dental Operating Microscope*

*EDTA: Ethylenediaminetetraacetic Acid*

*EMD: Enamel Matrix Derivative*

*GR: Gingival Recession*

*MIS: Minimally Invasive Surgery*

*PD: Probing Depth*

*RCT: Randomized Controlled Trial*

*SRP: Scaling and Root Planing*

*VAS: Visual Analog Scale*

*VMIS: Videoscope-Assisted Minimally Invasive Surgery*

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