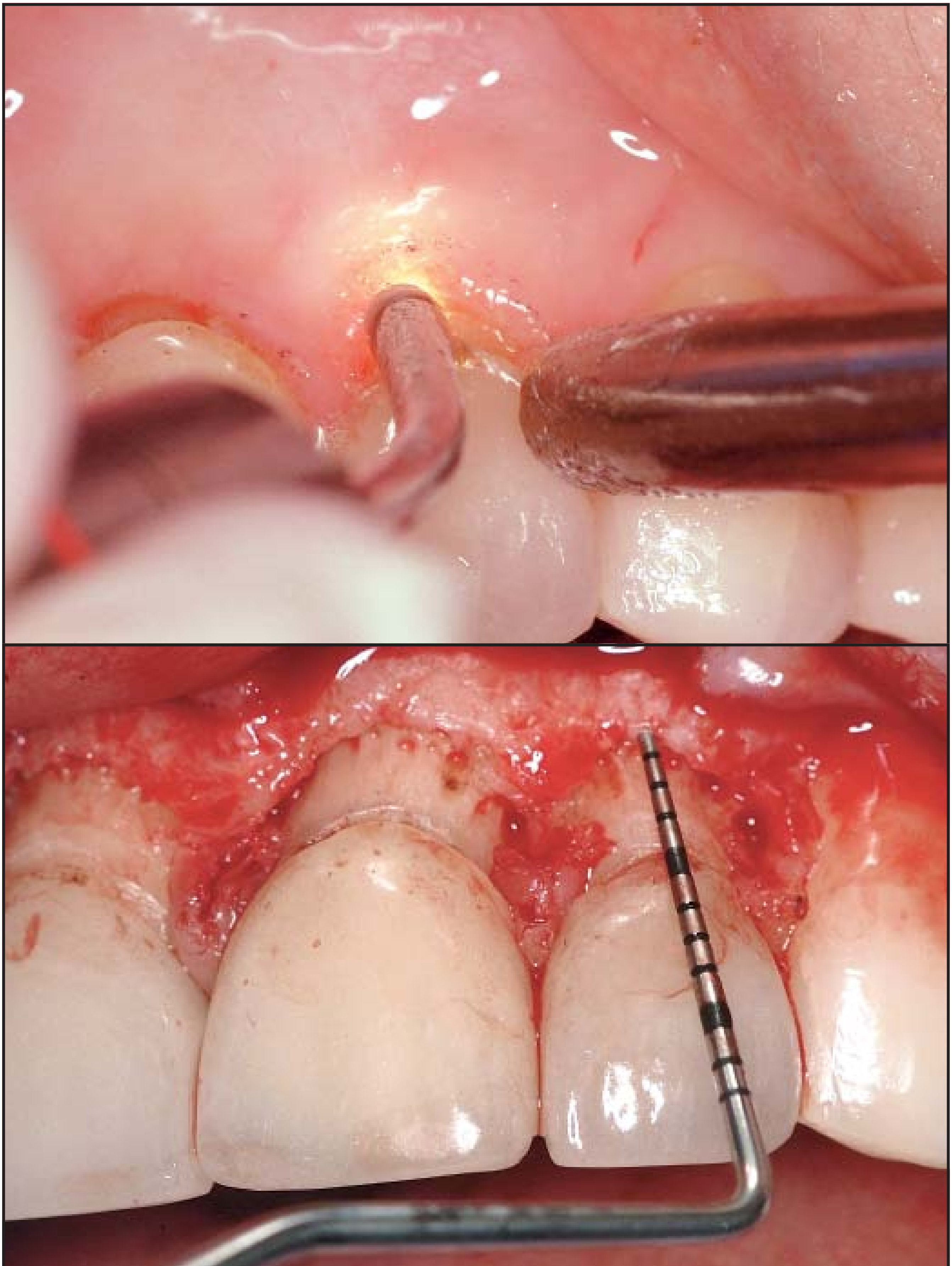

Laser-Assisted Flapless Crown Lengthening: A Case Series

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As part of the paradigm shift toward more minimally invasive surgical procedures, increasing numbers of references to laser-mediated flapless crown lengthening are noted in the published literature. The vast majority of these references are noncontrolled case reports or technique-focused articles. Therefore, prospective, randomized controlled studies that objectively examine the safety and efficacy of flapless crown lengthening are lacking. The current case series represents an initial attempt to examine some of the clinical issues posed by this minimally invasive flapless approach. Ultimately, only well-designed controlled clinical trials can yield the type of evidence-based data necessary to categorize this approach to crown lengthening as standard-of-care treatment. (Int J Periodontics Restorative Dent 2011;31:357–364.)

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The development of minimally invasive procedures currently enjoyed by medicine is beginning to impact dentistry.[1–10] In medicine, and to a lesser extent in dentistry, evolving technologies have served to expand the indications for minimally invasive procedures.[11–13] As part of this expansion of supporting technologies, lasers have become significant surgical adjuncts in medical practice.[14–17] In dentistry, lasers, although currently less integral to advances in minimally invasive procedures, are nevertheless evolving as potentially effective adjunctive tools within this therapeutic arena.[18–21] In periodontics, minimally invasive flapless crown lengthening may be one procedure where lasers can play a significant therapeutic role.

Common to all crown lengthening procedures is the need for meticulous attention to maintaining the anatomical requirements of the biologic width, which, if violated, can lead to chronic inflammation, attachment loss, and recession.[22–25] Accurate and careful osseous resection that allows space for each component of the biologic width, understood to be approximately 3 mm depending on the individual, is therefore an absolute prerequisite for stable, long-term outcomes following crown lengthening procedures.[22,24–27]

Cobb, in a 2006 literature review of lasers in periodontics, raises a number of questions and issues that need addressing to support laser-mediated functional and esthetic flapless crown lengthening with valid and reliable evidence-based data[28]: "*(1)* Is there sufficient tactile sensation transmitted through the laser tip to allow the clinician to adequately distinguish between bone and root surface, cementum, and/or dentin? *(2)* Have any of these reports determined if the roots of the treated teeth incur damage, eg, cratering, ditching, charring, heat-induced cracking, or melting? *(3)* In cases requiring bone removal, does lack of direct visualization allow the clinician to establish proper anatomical dimension and contours that will maintain the gingival papilla post-surgically and prevent violation of the biologic width?" It is the purpose of this limited prospective case series study to begin an initial examination of some of these questions.

Method and Materials

All subjects in the current single-site consecutive patient case series required esthetic crown lengthening procedures in the anterior esthetic zone of the maxilla. To observe and document immediate intraoperative findings following flapless crown lengthening, as well as to correct potential problematic sequelae of the closed procedure, full-thickness mucoperiosteal flaps were to be reflected immediately following the flapless procedure. Patients were informed in detail of the nature and potential risks of the proposed closed and open-flap procedures, and informed consent was reviewed and signed.

Presurgical work-up included a complete clinical periodontal and radiographic examination, preoperative photographs, diagnostic models, wax-up of ideal incisor and canine tooth morphology, and precise documentation of current and proposed incisal edge and cementoenamel junction (CEJ) positions (Fig 1). A surgical guide was then constructed that allowed for the transfer of proposed gingival margins to the patient using a surgical marker (Figs 2a and 2b).

Flapless crown lengthening procedure

External beveled gingivectomy

Following administration of local anesthetic and using a North Carolina periodontal probe, the patient's presenting biologic width parameters and crestal bone position were verified. A 90-degree, 600-μm-diameter, 3-mm-long tip was attached to an Er:YAG laser and used for both soft and hard tissue ablation procedures (Fig 3). To modify the patient's gingival margin, the Er:YAG settings were as follows: 75 mJ of energy, 3.0 W, and a pulse rate of 40 Hz. Holding the quartz tip 1 to 2 mm from the soft tissue surface, the existing gingival margin was vaporized, and a properly contoured, more apically positioned, predetermined gingival margin was created (Fig 4).

Osseous resection

Following laser-mediated gingivectomy, bone sounding was performed to determine the position of the osseous crest relative to the newly formed gingival margin (Fig 4). In this case, the osseous crest was level with the gingival margin, mandating osseous resection to satisfy biologic width requirements.

Using the same quartz laser tip set at 50 mJ, 30 Hz, and 1.5 W, with water expressed from the tip, the tip was placed into the sulcus parallel to the long axis of each tooth. Holding the tip approximately 1 mm from the osseous crest, the tip was then advanced apically to its full 3-mm length—the apical resection required to satisfy biologic width requirements (Fig 5). The Er:YAG laser tip was then carefully moved laterally from mesial to distal and back following the contours of the CEJ to attempt a uniform osseous ablation at least 3 mm in height at each treated site. Following the apical ostectomy, an attempt was then made to prevent troughing at the cervical osseous margin by repositioning the laser tip to recontour the crestal portion of the labial cortical plate. Throughout the ostectomy procedure, care was taken to avoid contacting the root surfaces with the laser tip.

Fig 1 *Patient at initial preoperative examination and work-up for surgical correction of excessive display of gingival and tooth asymmetry when smiling.*

Fig 2a *Surgical guide allowing transfer of the proposed, more apically positioned gingival margin determined during comprehensive diagnostic examination.*

Fig 2b *With the surgical guide in place, the proposed gingival margin was transferred to the patient's tissues via a surgical marking pen.*

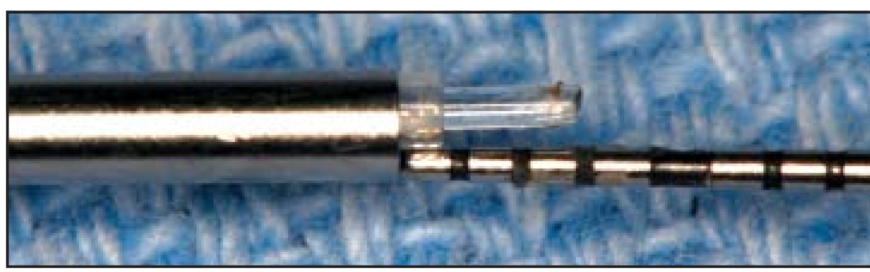


Fig 3 *The quartz laser tip was 3 mm in length—the linear distance required to accommodate the elements of the patient's biologic width.*

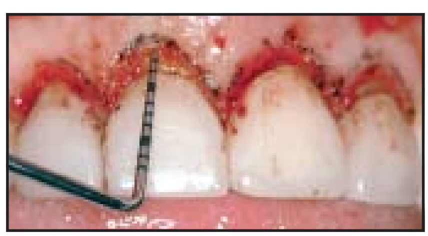


Fig 4 *Following laser-mediated gingivectomy, bone sounding revealed the osseous crest at the newly positioned gingival margin. Osseous resection was therefore required to create space for the biologic width.*

Fig 5 *Er:YAG quartz tip advanced apically 3 mm during ostectomy procedure.*

Fig 6 (left) *Full-thickness flap reflection revealed bone troughing and root surface scorch damage following flapless crown lengthening.*

Fig 7 (right) *Bone troughing was eliminated and root surface damage reduced during the open-flap portion of the study.*

Fig 8a *Thin biotype: Preoperative documentation with periodontal probe visible through a very thin marginal gingiva.*

Fig 8b *Preoperative view with provisional partial dentures at the maxillary lateral incisor positions, which were later replaced with implant-supported restorations.*

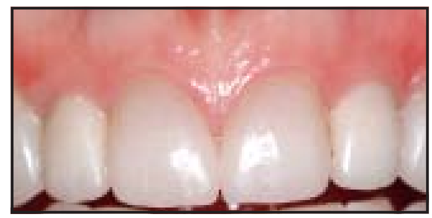


Fig 8c *Three-year postsurgical results.*

Open flap procedures

Using a 15c scalpel blade, an intrasulcular and beveled papilla-sparing interproximal incision was made, and a full-thickness labial flap was reflected. All aspects of the exposed area were then closely evaluated, and any necessary modifications were performed with either laser or rotary and hand instrumentation. If bone troughing was noted, a quartz "chisel" tip was used to eliminate the troughed area. A periodontal probe was used to verify the needed 3-mm space from the newly configured gingival margin to the osseous crest (Fig 6). Imprecise or poorly executed osseous resections were corrected (Fig 7). Lastly, roots were planed and scaled as needed in an attempt to eliminate root surface charring or pitting (Fig 7).

Postoperative care and long-term follow-up

Postoperative care consisted of over-the-counter nonsteroidal anti-inflammatory drugs and prescription analgesics as necessary. Chlorhexidine swabbing and rinsing were required for the first 2 weeks following surgery. Patients were instructed not to brush or floss for the first week postoperative. At 1 week, light brushing and flossing were allowed, followed by normal home care at 1 month. Patients were advised to avoid biting with the "front" teeth for the first week postsurgery and were placed on soft diets through postoperative week 2. When possible, patients were followed for 3 years.

Fig 9a *Moderate biotype: Preoperative photograph documenting unesthetic short clinical crowns and excessive gingival display (prior to treatment, the patient declined orthodontic therapy to correct the occlusal plane).*

Fig 9b *Stable and esthetic 3-year postsurgical results (postoperative view of Fig 2).*

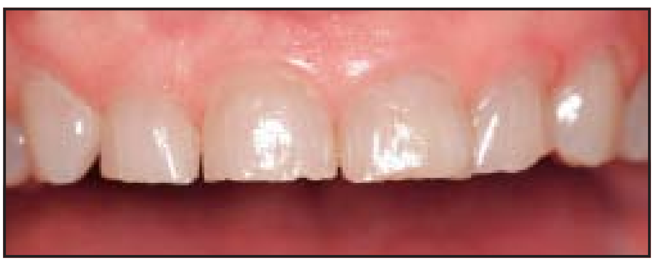


Fig 10a *Thick biotype: Preoperative documentation of short clinical crowns with excessive incisal edge attrition.*

Fig 10b *Esthetic and stable 3-year results of the crown lengthening procedure.*

Results

Long-term follow-up observations

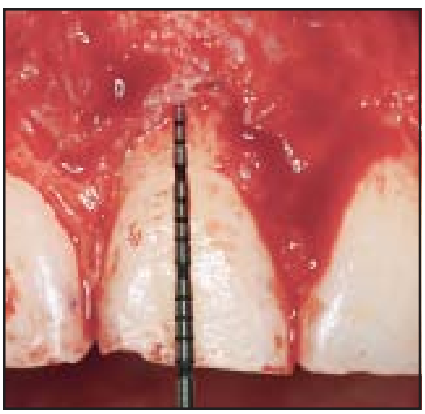
Throughout this prospective case series, patient compliance for all treatment-related parameters remained high. All patients were followed postoperatively for 6 months, and 57% of study subjects were available for 3 years. Esthetics and periodontal health parameters, including the position of the gingival margin, health of the attachment apparatus, and patient satisfaction with esthetics, remained stable and positive throughout the duration of this study. Regardless of the presenting biotype, 3-year documentation appeared to indicate stable and esthetically successful laser-mediated treatment results (Figs 8 to 10).

Intraoperative osseous observations

Following flapless ostectomy, a number of osseous-related findings were observed. Regardless of the biotype treated, consistent osseous troughs were noted at the apically repositioned osseous crests of each treated patient. In spite of reports in the literature that such troughs can be procedurally avoided, which was attempted in this study by striving to tactilely sense and eliminate bone troughing during the closed flap procedure, bone troughing could not be avoided (Figs 11a and 11b).[29] Equally important, insufficient and ragged bone removal was frequently observed following closed ostectomy procedures designed to establish adequate space for the reestablishment of biologic width (Figs 12a and 12b).

Fig 11a (left) *Bone troughs noted immediately following closed laser-mediated crown lengthening procedure (same patient as that depicted in Fig 8, thin biotype).*

Fig 11b (right) *With full-thickness flaps reflected, bone troughs were eliminated with the Er:YAG laser.*



Figs 12a and 12b (left) *Insufficient and ragged bone removal seen following the flapless crown lengthening procedure.* (right) *Laser-induced root scorching damage was also apparent (this patient's pre- and postoperative photographs are depicted in Fig 9, moderate biotype).*

Intraoperative root surface observations

Root surface pitting secondary to laser-induced charring was observed at a number of sites following flapless crown lengthening. Despite great care to avoid laser contact with tooth root surfaces and despite the end-cutting–only nature of the Er:YAG laser, root surface damage could not be predictably avoided (see Figs 6 and 12b).

Discussion

As the paradigm shift toward minimally invasive procedures actively expands in medicine and dentistry, laser-mediated flapless crown lengthening continues to receive ongoing attention in the dental and periodontal literature. Proponents of this procedure reference a number of laser- and technique-specific claims in support of erbium laser–mediated flapless crown lengthening.[22,29,30–36]

The current case series study found a number of osseous- and root-related intraoperative findings common to the closed crown lengthening approach. It was surprising to the authors that prior to this paper, no one had elevated a flap to examine the results of laser-assisted flapless crown lengthening. The most consistent findings following Er:YAG laser–mediated flapless crown lengthening occurred during laser ostectomy. At each site, significant bony troughs were noted at the now more apically positioned osseous crest regardless of the biotype treated and the efforts to mitigate or eliminate such troughing by changing the position of the laser tip and attempting osseous recontouring out toward the labial cortical plate. In addition, imprecise, ragged, and insufficient bone removal was often noted when ostectomies were performed to establish sufficient space for elements of the biologic width. Laser-induced root scorching was also evident at a number of sites in spite of care taken to avoid direct contact with root surfaces by positioning the laser parallel to the long axes of the treated teeth.

In this case series, full-thickness mucoperiosteal flaps were reflected following flapless crown lengthening for two purposes: *(1)* to observe and document immediate intraoperative findings and *(2)* to clinically modify potentially problematic surgical sequelae. As noted above, both osseous- and root-related problems were encountered. Critical to long-term periodontal stability following any approach to crown lengthening is the need to not violate the space requirements of the biologic width. Violating the biologic width risks ongoing inflammation, attachment loss, and recession.[22–25] It was apparent that at many sites, inadequate and imprecise ostectomy results would likely result in violation of the biologic width, and therefore corrective open-flap ostectomy steps were taken.

In addition to biologic width concerns, cervical osseous troughs present in various degrees in each case posed immediate clinical concerns and questions. Would these surgically created defects self-correct through bony remodeling over time? Would these osseous troughs eventually act as intrabony defects and initiate subsequent periodontitis? What would be the attachment apparatus tissue response should these troughs persist over time? Would the postoperative gingival margin and papillae remain stable over time? Not knowing the answers to these questions mandated open-flap surgical correction and elimination of these technique-created osseous defects.

In addition to modifying the osseous results, attempts were also made to remove root pitting secondary to laser-induced charring noted at a number of sites following the closed crown lengthening procedure. Affected roots were planed and scaled. However, despite root instrumentation, residual pitting tended to persist. As in the osseous findings, clinical concerns regarding the long-term effects of persistent root surface damage remain.

Importantly, the long-term esthetic results seen in this case series remained stable and successful. This is not surprising since the surgical guidelines for preservation of the biologic width were followed, and when done correctly, the outcome of crown lengthening is stable over time. Whether these results would have persisted without secondary open-flap intervention is currently unknown. It is not the purpose of this paper to disparage the use of dental lasers. The authors are not aware of any instrument that can be used in every situation on every individual. Dental lasers have great potential, and it is the authors' hope that the laser industry will fund randomized controlled trials that will allow clinicians to better understand appropriate techniques and patient selection to optimize clinical outcomes. Minimally invasive surgeries, including the current procedure, require firm grounding in solid evidence-based data. If flapless crown lengthening is to become an accepted, standard-of-care treatment, such evidence-based information can only come from well-designed, prospective controlled clinical trials.

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