



Guided Soft and Hard Tissue Preparation: A Novel Technique for Crown Lengthening

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This article presents an innovative approach to crown lengthening that offers predictable esthetics and harmonious bone and gingival contours. Following fabrication of the diagnostic wax-up, a provisional fixed prosthesis is constructed. At the time of provisional insertion, the tooth, marginal gingiva, and crestal bone are prepared with rotary instruments using a prosthetic template as a guide. This procedure is known as guided soft and hard tissue preparation. The provisional is then inserted, thus invading the biologic width. Within no more than 2 weeks, bone resective surgery is performed to recreate normal biologic width. A well-defined preparation margin acts as a guide during the osteoplasty procedure, which is used to reestablish the correct distance between the crown margin and crestal bone. A total of 10 patients in need of crown lengthening have been treated with this procedure, and 1- to 7-year follow-ups have shown good esthetic results and stable tissue levels. *Am J Esthet Dent* 2013;3:24–37. doi: 10.11607/ajed.0049

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Dental clinicians must overcome a series of obstacles when the natural relationship between the clinical crowns and soft tissue has been altered.^{1,2} The primary challenge is placement of the restoration margin without damaging the integrity of the dentogingival junction, which can result in iatrogenic chronic gingivitis or loss of attachment and bone resorption.^{3,4} The average dimensions of the dentogingival complex were first described Gargiulo et al,⁵ who reported the following measurements based on human cadavers: 0.69 mm of sulcus depth, 0.97 mm of epithelial attachment, and 1.07 mm of connective tissue attachment. In contrast, Kois⁶ reported a healthy clinical sulcus depth of 1 to 4 mm. The definition of biologic width introduced by Cohen⁷ is the combined dimension of the connective tissue and epithelial attachment on the root surface above the bone crest. Ingber et al⁸ defined the biologic width as the measurement between the bottom of the gingival sulcus and the alveolar bone crest and described the cemento-enamel junction (CEJ) as approximately 1.55 mm from the bone crest. In a study of human cadaver jaws, Vacek et al⁹ reported measurements of 1.14 mm for epithelial attachment and 0.77 mm for connective tissue attachment. The latter was the least variable among all tissue dimensions and was significantly greater on tooth surfaces with subgingival restoration.^{10,11} Radiographic studies showed that the mean distance between the CEJ and bone crest was 2.05 mm, with significant variations in this dimension.^{12,13} Dimensional changes of the biologic width are also related to variations in the relationship between the bone crest and CEJ among the patient population. In patients with a normal crest (85% of the population), the distance between the alveolar crest and CEJ is approximately 2 mm; in patients with a high crest (2% of the population), the distance between the alveolar crest and CEJ is less than 2 mm; and in patients with a low crest (13% of the population), the distance between the alveolar crest and CEJ is more than 2 mm. The depth of the sulcus also plays a relevant role. Two patients with a low crest can have different biologic reactions to the placement of a restoration margin based on the sulcus depth. Even if each patient has a total measurement of 5 mm from the gingival margin to the alveolar crest, one may have a 3-mm sulcus depth and 2-mm attachment apparatus (low crest unstable; greater risk of recession) while the other may have a 1-mm sulcus depth and 4-mm attachment apparatus (low crest stable; recession less likely).^{6,8,14}

**Table 1** Characteristics of the Treated Cases

Patient	No. of teeth	Year treated	Tooth position*	Restoration
1	3	2004	6 / 7 / 8	PFM
2	6	2005	6 / 7 / 8 / 9 / 10 / 11	Zirconia
3	6	2005	6 / 7 / 8 / 9 / 10 / 11	Zirconia
4	1	2007	9	Zirconia
5	2	2007	6 / 7	Zirconia
6	4	2010	7 / 8 / 9 / 10	Lithium disilicate
7	6	2010	6 / 7 / 8 / 9 / 10 / 11 / 12	Lithium disilicate
8	4	2010	6 / 8 / 9 / 11	Zirconia
9	5	2011	7 / 8 / 9 / 10 / 11	Acrylic resin
10	1	2011	6	Acrylic resin

PFM = porcelain fused to metal.

*Universal tooth-numbering system.

It is also important to consider variations in the relationship of the gingival margin to the alveolar crest from the midfacial vs the interproximal aspects; eg, in maxillary anterior teeth in patients with a normal crest, the distance from the alveolar crest to the gingival margin on the facial and palatal aspects is about 3 mm, while the distance from the alveolar crest to the gingival margin on the interproximal aspect is about 5 mm due to the height of the interproximal papilla.^{6,14}

To respect the normal biologic width and maintain healthy periodontal conditions, research has shown that a minimum distance of 3 mm between the bone crest and restoration margin is necessary when preparing a tooth.^{6,8,12}

The goal of respecting the integrity of biological width in terms of the restoration margin determines the need for crown lengthening.^{15,16} This condition can be observed in several clinical scenarios, including short clinical crowns, cervical decay, a restoration

margin placed deep in the sulcus, cervical tooth fracture, an altered emergence profile, and the need to extend the preparation 1.5 to 2 mm apically beyond the core material to achieve the ferrule effect. In all such cases, surgical crown lengthening is necessary.^{17–20}

Proper margin location and accurate tooth preparation, thus allowing for a proper contour and well-fitting restoration, also affect periodontal tissue health.²¹ To manage these conditions, crown lengthening is the treatment of choice.^{22–24} This article presents an innovative approach to crown lengthening that offers predictable esthetics and harmonious bone and gingival contours.

MATERIALS AND METHODS

A total of 38 teeth were treated in 10 patients, with a follow-up time of 1 to 7 years (Table 1). The case involving the most significant treatment will be



Fig 1 Preoperative smile.

discussed in this section as an example of the guided soft and hard tissue preparation procedure.

A 30-year-old female patient presented with complaints regarding the poor esthetics of her smile. She also requested replacement of her missing posterior teeth (Fig 1).

The smile analysis showed short and abraded teeth and a gummy smile with excess gingival display. In the anterior region, a diagnosis of tooth erosion, discoloration, and extrusion due to eating disorders was made based on measurement of the clinical crown dimensions and proportions and the presence of wear facets. In the posterior area, all premolars and molars on the right side were missing, as were the second premolar and all molars on the left side. Full-mouth radiographs and periodontal charting showed an excess of keratinized gingiva in the anterior area and minimal probing depths (1 to 2 mm) around the remaining teeth (Fig 2).

In the posterior segment, severe vertical and horizontal bone atrophy in the molar and premolar areas was diagnosed on both sides of the maxilla due to early loss of the posterior teeth. A computed tomography scan was requested.

Intraoral and extraoral photographs, impressions, and a bite registration were taken. Study casts were mounted on an articulator (Artex, Jensen Dental). All data were collected and transferred to the laboratory technician together with the clinical crown length measurements. The lengths of the clinical crowns of the maxillary right and left central incisors were 7 and 8 mm, respectively, with adequate root length (Fig 3).

Based on the wax-up, a resin mock-up of the seven anterior teeth was fabricated with the ideal dimensions and proportions and tried in to evaluate and discuss the esthetic results with the patient. It was decided to elongate the length of the central incisors to 11.5 mm.²⁵ Since the length of the right



Fig 2 Altered gingival and dental architecture.

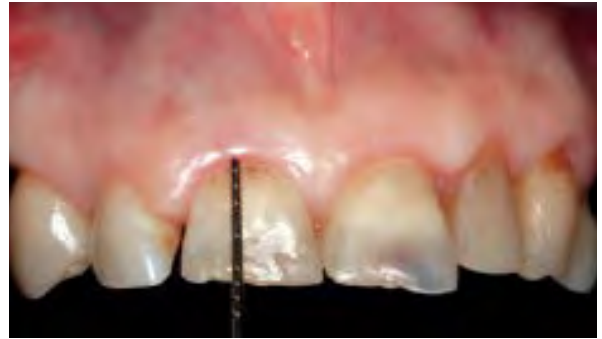


Fig 3 Reduced tooth dimensions due to erosion.

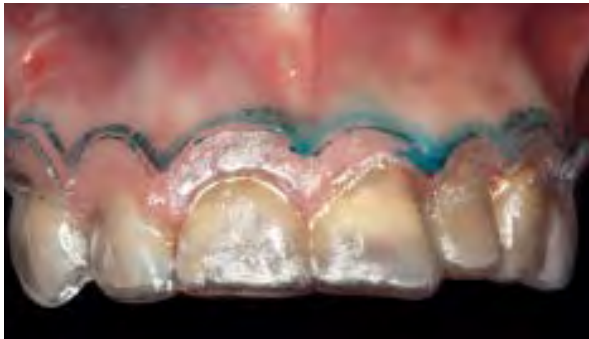


Fig 4 VPS stent used to mark the future gingival level.



Fig 5 Soft and hard tissue preparation.

central incisor was 7 mm, the treatment plan was to add 3 mm gingivally to correct the gummy smile and 1.5 mm incisally to improve the overbite.

The gingival contour on the stone cast was carved according to the treatment plan, and a vinyl polysiloxane (VPS) template and twin acrylic resin provisional restoration were made. The VPS stent was used only before the tooth preparation to mark the predicted gingival contour as planned on the diagnostic wax-up (Fig 4).^{26–28}

To improve smile esthetics, increase the tooth length, reduce gingival display, and provide more retentive abutments, an alternative crown-lengthening surgical procedure was proposed.

With patient approval, the so-called guided soft and hard tissue preparation procedure was performed. The tooth was prepared using a green-ring (150 μ m) diamond bur along the gingival margin, gums, and bone crest as necessary (Fig 5).

To avoid a quick inflammatory response that could create excessive bleeding during resective surgery, it was decided not to extend the gingival preparation too far apically into the interproximal area. The palatal preparation was minimal and was carried out at the level of the gingival margin.

A second template was used to check for vestibular, palatal, and interocclusal clearance (Fig 6).



Figs 6a and 6b Template in place to verify proper clearance.



Fig 7 Provisional restoration.

The interproximal tissues should not be included at this point in the preparation. The provisional was kept in position by a VPS shell and then relined. The margins were positioned deep inside the soft tissue and often in contact with the bone, thus violating the biologic width. The provisional was then bonded with temporary cement. At this stage, crown lengthening must be performed within 1 to 2 weeks to reestablish the correct distance of 3 mm from the gingival margin to the bone crest. The provisional prosthesis represents the ultimate esthetic blueprint by defining the morphologic goals of the final restoration (Fig 7).²⁴

One week later, crown lengthening was performed.¹² A full-thickness intra-

sulcular incision was carried out using a no. 15C Bard-Parker blade. A split-thickness incision was carried out both vestibularly and palatally in the papillary area, leaving the papilla core intact and anchored to the underlying bone. This procedure offers two major advantages: (1) it prevents the papillae from shrinking during healing and consequently avoids the formation of unesthetic black triangles, and (2) it makes stabilization of the vestibular and palatal flaps easier when anchoring them with the suture onto the papillary tissue.

A full-thickness mucoperiosteal flap was raised on the buccal and palatal sides to expose the bone crest. A partial-thickness flap was raised in the



Fig 8 Open flap showing the partial thickness in the interproximal area.



Fig 9 Measurement of the correct distance from the bone crest to crown margin.

interproximal areas to leave the periostium intact and avoid any interference with the bone peaks interproximally (Fig 8).²⁹

Next, the ostectomy and osteoplasty were carried out. At this stage, it is important not only to rely on the provisional margin to redesign the bone architecture but also to locate the preparation finishing line that was defined during preparation, which serves as an accurate reference point for bone recontouring.

A 2.5- to 3-mm distance must be kept between the provisional margin or finishing line and bone crest level to allow for reestablishment of normal biologic width.³⁰ A periodontal probe was used to measure the correct distance and remove the proper amount of bone (Fig 9).

Piezosurgical tips (PiezoSurgery, Mectron Medical Technology) were preferred to rotary instruments to redesign the bone architecture. These instruments offer easier control during the ostectomy and osteoplasty



Fig 10 Fine tuning of the piezosurgical bone resection.



Figs 11a and 11b Close-up views (a) before and (b) after bone removal for the reestablishment of the biologic width.

and increased safety in terms of the interproximal soft tissues (Fig 10).^{31,32} Hand instrument such as Ochsenbein chisels can be used for final refinement of the osteotomy (Fig 11). Whenever necessary, the provisional prosthesis can be relined to optimize sealing of the finishing margin.

Since the gingivectomy had already been performed at the time of tooth preparation, there was no need to further remove soft tissue or apically reposition the flap. This made it possible to

easily and harmoniously adapt the soft tissue on the new bone profile and stabilize it with a fine suture (6-0, Ethicon). A thin suture was chosen to minimize soft tissue scarring.

The provisional prosthesis was inserted using chlorhexidine gel as a luting agent. Chlorhexidine gel is usually preferred to temporary cement during the early healing phase because the provisional prosthesis will need to be removed 3 to 5 days later for suture removal. Further, the use of

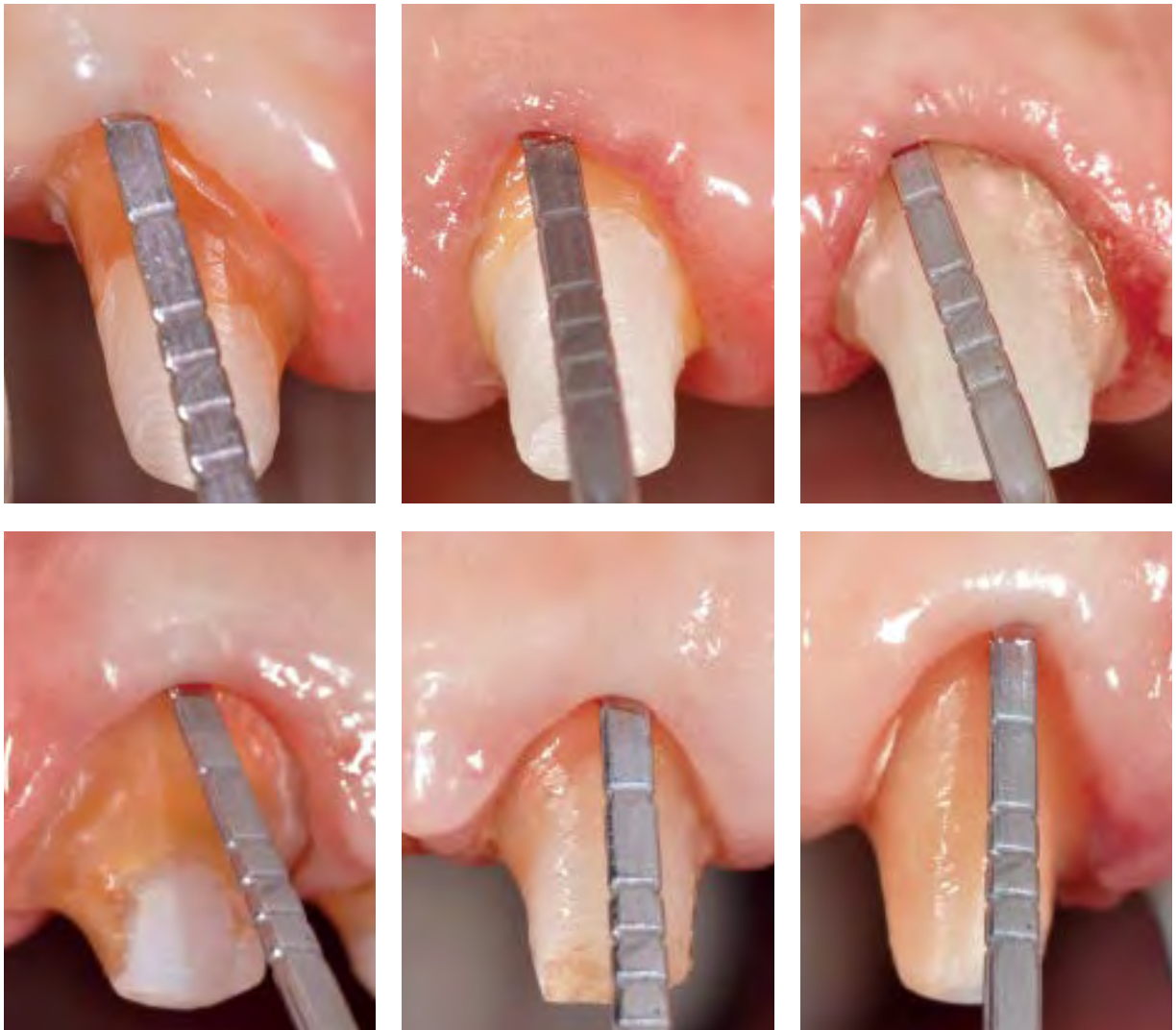


Fig 12 Bone sounding to confirm reestablishment of a healthy biologic width before final impression taking.

chlorhexidine gel avoids the presence of cement particles in the sulcus area, which can interfere with the formation of new attachment.

The patient was seen weekly during the first month for gentle cleaning and monitoring of healing and then monthly for the rest of the year to evaluate the soft tissue maturation.³³ Nine months after surgery, bone sounding showed

a constant distance of 3 mm between the bone crest and gingival margin on all anterior teeth, thus revealing successful reestablishment of the biologic width. Once complete tissue maturation was established, final adjustments could be carried out to correct minor esthetic discrepancies (Fig 12).

A new provisional prosthesis was made to improve the esthetics, fine tune



Fig 13 Final smile.



Fig 14 One-year follow-up.

the emergence profile, and guide final tissue conditioning, especially in the interproximal area. Three months later, the final impression was taken. Single lithium disilicate crowns were manufactured. The crowns were tried in to check the esthetics, comfort, phonetics, and occlusion. Minor adjustments were made, and the final prosthesis was bonded with resin cement.

RESULTS

Figs 13 and 14 show the final results of the sample case. A total of 38 teeth in 10 patients were treated with this technique, and the 1- to 7-year follow-up period showed stable tissue levels and healthy periodontal conditions.



DISCUSSION

Conventional crown lengthening consists of establishing the ideal location of the gingival margin, raising a flap, and removing up to 3 mm of bone.⁸

The ideal position of the gingival margin is determined using a diagnostic wax-up converted into a clinical template. A second option is to establish the margin location, remove the gingival tissue according to the template, prepare the tooth, and place the provisional margins at the predefined level.^{24–34} In this scenario, the crown-tooth interface violates the biologic width in anticipation of crown lengthening.^{25–35} This technique allows the preparation margin to act as a reference point for the surgeon, who must recreate the correct distance of 3 mm from the margin to the bone crest. It is only possible to apply this technique if the preparation margin is kept within the soft tissue and away from the bone.

This paper has described a new technique—guided soft and hard tissue preparation—that consists of the simultaneous removal of dental structure, gingival tissue, and crestal bone on the buccal and/or palatal aspect of the tooth.

The provisional prosthesis, which is inserted before resective surgery, defines the morphologic parameters of the final restoration.²⁴ The prepared marginal contour of the crowns provides the clinician not only with the final height but also with the correct contour and zenith position of the crown.⁶ This harmonious architecture can be redesigned on the bone crest while also keeping the crown margin at a constant distance of 2.5 to 3 mm from the bone crest.

According to Tarnow,²⁸ a minimum of 1 week is recommended for complete epithelial healing after gingival preparation; however, no more than 2 weeks should be allowed to pass to avoid tissue inflammation caused by the violation of the biologic width. Shorter or longer periods of time will create difficult conditions for the surgeon because of the presence of hyperemic and friable tissue with excessive bleeding and unpredictable shrinkage after healing.^{33–36}

The incision line is planned based on the analysis of two determining factors: the amount of bone to remove and the amount of keratinized gingiva present.³⁷ The first parameter indicates the amount of apical movement of the gingival margin needed to reestablish the correct relationship between the crown margin and bone-gingival complex. The second parameter dictates the amount of gingivectomy that can be performed without compromising the integrity of the band of keratinized tissue around the crown margin.³⁸

In fact, in all of the patients treated, some keratinized gingiva had already been removed with a bur by the restorative dentist at the time of soft and hard tissue preparation. Therefore, it was not necessary for the surgeon to further remove keratinized tissue. For this reason, the vestibular incision is made intrasulcularly to preserve the remaining band of keratinized tissue. On the palatal side, the amount of keratinized tissue is not of concern; thus, the incision line is only dictated by the bone level.

The osseous resective procedure is highly facilitated by this approach because the surgeon will have a well-



established reference point for bone removal: the tooth preparation finishing line. According to the ideal position of the contact point, the interproximal bone peaks will eventually be relocated.²⁹

Conventional protocols require 4 to 6 weeks for early healing of the periodontal attachment prior to initiating restorative procedures.²⁴ Pontoriero et al³³ reported that 6 to 12 months of healing are necessary before the maturation of gingival tissues is complete. Over this period of time, the tooth surfaces that were exposed due to crown lengthening will be displayed and black triangles may appear.^{33–39} These esthetic defects may occur alongside phonetic impairments and tooth sensitivity. These problems are solved by the guided soft and hard tissue preparation technique, which provides better comfort to the patient during healing and tissue maturation.

If the patient is satisfied with the esthetics, phonetics, and comfort (salivary flow, tooth sensitivity, and food impaction) the bone will be sounded at 6 and 9 months to check for complete tissue maturation. When the dentogingival complex is stable and tissue maturation is complete, the final gingival architecture can be evaluated and minor adjustments to the preparation margin can be made to optimize esthetics. At this stage, the final impression should be taken.^{40,41}

This technique is indicated for all cases in which a wide band of keratinized tissue is present (4 mm or more) and guarantees predictable results for patients with a thick biotype. In cases with a thin biotype, it is recommended to remove about 0.5 mm less of bone

during the ostectomy to compensate for further crestal bone loss during healing caused by flap elevation. Further, this technique is easier to perform with a well-defined horizontal tooth preparation (eg, chamfer, shoulder, 135 degrees). In contrast, difficulties may arise if a vertical preparation is used (eg, feather edge, knife edge, bevel).

The main advantages of this procedure are its precision, esthetic predictability, and comfort for the patient. With conventional crown lengthening, the surgeon must anticipate the position of the final crown margin to remove the proper amount of gingival tissue and bone.^{2–18} Conventional techniques may be predictable when restoring a single tooth; however, when multiple teeth are involved, thus requiring careful attention to symmetry, the results may not be as predictable. Further, in cases in which abrasion and extrusion have taken place (as in the case presented in this paper), the CEJ cannot be used as reference point. This means that the surgeon's eye and skill become the only tools to develop the optimal symmetry and correct distance of the future crown margin from the bone crest.

With the guided soft and hard tissue preparation procedure, the final crown margin has already been defined by the preparation performed by the restorative dentist. The surgeon thus has a reliable reference point to guide his hand during the osteoplasty.

One potential disadvantage of this technique compared to conventional crown lengthening is that two surgical procedures are involved; however, the first surgery is a minor gingivectomy



performed by the restorative dentist during tooth preparation. Postoperative discomfort for this procedure should be minimal.

CONCLUSIONS

The soft and hard tissue preparation technique is a modification of conventional crown-lengthening procedures that allows the surgeon to perform the bone resective surgery more precisely and predictably. This paper demon-

strates that the restorative margins can be considered an excellent landmark for the osteoplasty because they provide reliable information regarding the location of the final crown margins. Future studies with a larger number of cases are necessary to validate the predictability of this technique.

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