



A Standardized Approach for the Early Restorative Phase After Esthetic Crown-Lengthening Surgery



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The aim of the present case series article was to provide a standardized approach for the early restorative phase after a crown-lengthening surgical procedure. Different advantages can be ascribed to this approach: the clinician can prepare a definitive prosthetic finishing line in the supragingival location; the early postsurgical temporization allows the conditioning of soft tissues, especially the interdental papillae, during their maximum growing phase; and the clinician can choose the time for the definitive prosthetic rehabilitation in a patient-specific manner according to the individual potential and duration of the soft tissue rebound. In this study, this standardized approach was applied to the treatment of two esthetic cases requiring crown-lengthening procedures. (Int J Periodontics Restorative Dent 2015;35:601–611. doi: 10.11607/prd.2444)

A fundamental prerequisite for successful dental prosthetic rehabilitation is the presence of a healthy periodontium.¹ The achievement of an esthetic restoration that is perfectly integrated with the surrounding soft tissues requires a multidisciplinary approach and close collaboration between experts in periodontics and restorative dentistry.²

To manage clinical situations such as subgingival caries, crown or root fractures, altered passive eruption, cervical root resorption, and short clinical abutment, the crown-lengthening surgical procedure is necessary to allow placement of supragingival restorative margins and juxtagingival crown contours. In surgical crown lengthening, the biological width (BW) is reestablished at a more apical position to avoid violation of the BW that may result in bone resorption, gingival recession, gingival inflammation, or hypertrophy.^{3–6}

Crown lengthening for prosthetic reasons has the main goal of providing proper tooth preparation and retention of prosthetic restorations. It has been suggested that at least 4 mm of dental structure should be exposed above the soft tissue margin. In addition, prosthetic restorations require a 360-degree collar of the crown, also called the *ferrule effect*, surrounding the

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parallel dentin walls coronal to the crown margin. At least 1 mm of dentin wall coronal to the crown margin is sufficient to prevent failure.⁷

When crown lengthening is required for prosthetic reasons, the time required between resective surgery and restorative procedures has always been a matter of concern to clinicians. Some clinicians provide an immediate vertical feather-edge preparation during crown-lengthening surgery, allowing easier access and identification of the preparation margins. After apical flap repositioning, the teeth are immediately temporized with preformed or customized acrylic crowns.⁸ Others, after performing crown-lengthening surgery, refrain from any tooth preparation or restorative treatment for at least 6 to 12 weeks, because of the possibility of gingival recession during the postoperative healing phase.^{9,10}

Of the many studies¹¹⁻²² that have suggested a waiting period before proceeding with the final prosthetic phase, very few have provided different suggestions on how to use provisional restorations^{8,23}; however, none have provided standardized protocols. The aim of the present article was to provide a standardized protocol for the early restorative phase in esthetic cases requiring crown-lengthening surgery.

Biological rationale

BW is a clinical term coined by Cohen²⁴ for the histologic dentogingival junction described by

Sicher.²⁵ It is composed of junctional epithelium and connective tissue attachment. This term is based on the work of Gargiulo et al,²⁶ who reported an average BW of 2.04 mm. A recent systematic review showed that intra- and interindividual variance did not permit the determination of a magic number for the BW, but two meta-analyses found the mean value to range from 2.15 mm to 2.30 mm.²⁷ Periodontal and transgingival probing may be helpful for determining the dimensions of the BW before surgery,²⁷ considering the fact that periodontal probing is influenced by the force used and the inflammatory state of the periodontal tissues.²⁸⁻³⁰

Violation of the BW results in bone resorption to allow its restoration in a more apical position.⁴⁻⁶ Of the two BW components, junctional epithelium and connective tissue attachment, violation of the latter (and in particular, of the root cementum into which the connective tissue fibers insert) induces an inflammatory reaction leading to the production of inflammatory molecules (proteases, cytokines, prostaglandins, and host enzymes).^{31,32} This will activate osteoclasts to induce bone resorption.³³ The thickness of the bone in relation to the dimension of the inflammatory infiltrate determines whether bone resorption is horizontal or vertical. Because the inflammatory infiltrate occupies an area of about 1.5 mm (range: 1 to 2 mm) in diameter,³⁴ if the thickness of the bone is less than 1.5 mm an even bone resorption will be expected. However, vertical

bone resorption will occur for bone thicker than 1.5 mm. The behavior of soft tissue in an area of BW violation varies in relation to the type of bone resorption and to the thickness of the connective tissue between the sulcular/junctional and oral epithelium. In the presence of thin (< 1.5 mm) connective tissue, even bone resorption and gingival recession will take place.³⁵ In contrast, in the presence of thick connective tissue and bone, a pocket with a vertical bony defect will occur.³⁶ The aforementioned biological considerations lead to spontaneous crown lengthening as a consequence of BW violation where the bone and soft tissue are thin (ie, at buccal and palatal/lingual sites with thin bone [incisors and canines]). Conversely, surgical crown lengthening is indicated when violation of the BW occurs in the presence of thick bone and soft tissue (ie, at interdental sites, and at lingual sites when the lingual bone is thick [molar areas]).

Because the reduced thickness of soft tissue and bone are determining factors for crown lengthening to occur and remain stable over time, the most significant surgical steps are split-thickness surgical papilla elevation, thinning of the palatal flap, and osteoplasty (reduction of the buccolingual dimension of the bone). These steps, together with root planing up to the bone crest and apical positioning of the flap, create conditions for early postsurgical (about 2 to 3 weeks after surgery) crown lengthening of about 3 mm at the interdental site, and of about 2 mm

at the buccal and palatal/lingual sites, even without surgical osteotomy. During this period of 2 to 3 weeks, the surgically thinned bone resorbs to leave healthy root cementum available for connective tissue attachment to form in a more apical position.³⁷ The area previously occupied by the connective tissue attachment, where intrasurgical root planing was performed, becomes a hard, smooth, and clean surface onto which the epithelial cells can produce hemidesmosomes and create the epithelial junction.³⁸ At this point, the probing pocket depth is zero and interdental papillae are absent. The subsequent coronal maturation of the soft tissue to form the gingival sulcus and interdental papillae is called soft tissue rebound, which is a phenomenon that lasts longer than 1 year after surgery and is responsible for a progressive reduction of the crown lengthening that was achieved immediately after surgery (2 to 3 weeks).³⁹ Thus, from a clinical viewpoint, there is a period of about 1 month after the first 2 to 3 weeks following surgery when, after soft tissue maturation, the tooth structure that will become subgingival is still supragingival. This is the period during which the early restorative therapy should be performed. In this period, in fact, fillings can be easily isolated (using a rubber dam) because of the distance of the soft tissue and definitive abutment preparation and provisional relining are facilitated by the possibility of operating in the supragingival environment.

Soft tissue conditioning and growth of the interdental papillae

One of the main advantages of the early postsurgical restorative approach, together with the possibility of work in the supragingival location, is the possibility to condition interdental soft tissue growth. Two to three weeks after resective surgery, the interdental papillae are almost absent because the interdental soft tissue has yet to begin the maturation process. Many factors influence the postsurgical coronal growth of the interdental papillae, among which the most important are the distance from the abutments at the level of the bone crest, the shape of the roots, the patient biotype, the amount of interdental bone loss, and the distance from the contact point to the bone crest.^{18,39,40} The greater the distance from the abutments because of anatomic (more conical-shaped roots) or pathologic (greater bone loss) reasons, the less spontaneous growth of the interdental papillae may occur. Furthermore, when the distance from the contact point to the interdental bone crest is 5 mm, the papillae fill the interdental space in 98% of clinical cases, whereas when the distance is 6 mm or more than 7 mm, the papillae fill the interdental space completely in 56% and 27% of clinical cases, respectively.⁴⁰ Thus, it can be speculated that if the contact point between the first temporary crowns is applied 5 to 7 mm from the bone crest, the probability

of the papillae completely filling the interdental space decreases from 98% to 27%. Tarnow et al⁴⁰ found that under ideal conditions it is possible that the tip of the interdental papillae is located more than 7 mm coronally with respect to the bone crest. The objective of the approach described in the present article was to reproduce the ideal conditions for interdental papilla growth with temporary crowns. This was done by progressively changing the emergence profile and the position of the contact points during the maturation phase of the interdental soft tissues. In temporary crowns, which were applied 3 weeks after surgery, the first contact point was placed at a distance of about 3 mm from the soft tissue (about 5 mm from the bone crest). Because the rebound phase of the interdental soft tissue had just started, the papillae completely filled the interdental space very quickly (in about 3 weeks). Once the papillae had filled the space, the emergence profile of the temporary crowns was modified, and the contact point was shifted 1 mm coronally. After a few weeks, when the papillae had filled the interdental space, the temporary crowns were further modified to shift the contact point 1 mm further coronally (Table 1). With such an approach, almost all of the interdental papillae might grow 7 mm or more coronal to the bone crest, independent of the distance from the abutments or the shape of the roots and the amount of interdental bone loss.

Table 1 Timing of the clinical steps after the clinical crown lengthening

Time	Clinical steps
0	Surgical crown lengthening. Thickness reduction of the soft tissue with split-thickness papilla elevation and thinning of the palatal flap and osteoplasty to reduce the buccolingual dimension of the bone.
2 wk	Suture removal. Alginate or high-precision material impressions are taken to build a second series of relineable provisional restorations. No soft tissue retraction cords are used.
3 wk	Abutment and finishing line preparation. Relining of the provisional restoration with a 3-mm contact point from the interdental soft tissue.
6 wk	Check of the interdental papillae growth. If the papillae have filled the interdental space, the emergence profile of the temporary crowns is modified with the contact points shifted coronally by an additional 1 mm.
10 wk	Check of the interdental papillae growth. If the papillae have filled the interdental space, the temporary crowns are further modified to shift the contact point even more coronally by 1 mm.
4 mo	If the papillae have filled the interdental space, the temporary crowns are further modified to shift the contact point even more coronally by 1 mm.
6 mo	The time for the final impression is specifically chosen in each patient when there is no further growth of the interdental papillae at the last control visit, with respect to the last contact point of the temporary crowns.



Fig 1 Baseline findings in case 1. (left) Labial aspect of an anterior segment requiring surgical crown lengthening for prosthetic and esthetic reasons. All teeth, from canine to canine, are affected by altered passive eruption and the two incisors needed prosthetic restoration. (right) Palatal view of two central incisors needing crown lengthening and prosthetic rehabilitation.



Fig 2 Baseline findings in case 2. (left) Labial aspect of the previous prosthetic rehabilitation. (right) The anterior segment, after removal of the previous restorations and state of the abutments requiring surgical crown lengthening for prosthetic reasons.

Treatment planning and presurgical procedures

Two clinical cases requiring surgical crown lengthening for esthetic reasons were chosen (Figs 1 and 2). Preliminary extraoral and intra-oral photographs and radiographic images were taken to define the treatment planning. High-precision

impressions (using polyether/polyvinyl siloxane) of the maxilla and mandible were taken together with intercuspal position silicon to develop master split-cast models. In addition, smile lines were assessed for esthetic reasons, and wax-ups were analyzed to evaluate the spaces, shapes, and dimensions of teeth. The next step was to manufacture

a first provisional restoration built from the wax-ups and rebased after reconstruction of the abutments (Figs 3 and 4).

Presurgical cause-related therapy typically consisted of conservative, endodontic, prosthodontic temporary restorations and non-surgical periodontal treatments. The patient received a session of

Fig 3 First provisional restoration in case 1. (left) Abutment reconstruction and (right) first provisional restoration after relining.



Fig 4 First provisional restoration in case 2. (left) Abutment reconstruction and (right) first provisional restoration.



prophylaxis to remove microbial deposits, as well as instructions in proper oral hygiene, scaling, root planing (if necessary), and professional tooth cleaning with the use of a rubber cup and a low-abrasive polishing paste. Surgical treatment was not scheduled until the patient could demonstrate an adequate standard of plaque control.

Surgical technique

The crown-lengthening surgical technique consisted of an apically positioned flap with osseous surgery (Figs 5 and 6). In brief, inverse bevelled submarginal incisions, split thickness elevation of the surgical papillae, full-thickness buccal flap reflection, and thinned palatal flap elevation were performed. After removing secondary flaps, osteoplasty to reduce the buccolingual dimension of the bone and osteotomy to expose an adequate

dental structure above the osseous crest for restorative purpose were performed using diamond burs and hand chisels. Following osseous surgery, the exposed root surfaces were accurately planed with curettes up to the bone crest. No intrasurgical preparation of the abutments was performed, and no attempt was made to modify the natural emergence profile of the abutments from the bone crest. The flaps covering the buccal and palatal bone crests were stabilized by single vertical mattress sutures (polyglycolide 6-0) anchored buccally to the periosteum. The interdental bone was left exposed, allowed to heal by secondary intention. The provisional restorations were cemented with calcium hydroxide lining cement with no need to reline them, because the shape and preparation of the abutments were left untouched during surgery. Patients were instructed not to brush their teeth in the treated

area, but to rinse for 1 minute with 0.12% chlorhexidine solution three times a day.

Prosthetic procedures and timing of provisional restorations

Table 1 shows the timing of the clinical steps for the prosthetic phase after surgical crown lengthening. The early abutment preparation and temporization of the two clinical cases are shown in Figs 7 and 8. Two weeks after surgery, the first provisional restoration was removed, the sutures could be safely removed according to the healing of soft tissue, and soft mechanical plaque control was restarted. During this appointment, alginate or high-precision material impressions were taken with respect to the tissues (no soft tissue retraction cords were used) to build a second series of relinable provisional restorations.

Fig 5 Surgical technique in case 1.

Figs 5a and 5b (left) Vestibular and (right) palatal views after flap elevation and secondary flap removal. The flap was elevated from canine to canine to treat the altered passive eruption affecting the lateral incisors and the canines.

Fig 5c Clinical view after osteoplasty and ostectomy (at the level of the abutments only).



Figs 5d and 5e The labial flap (left) and palatal flaps (right) were sutured with vertical mattress sutures anchored to the periosteum.

Fig 5f The temporary crowns were cemented with no need for rebasing.

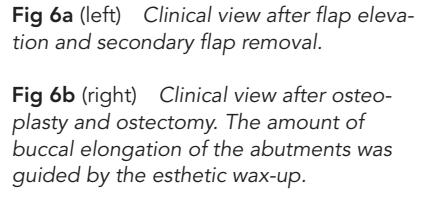
Fig 6 Surgical technique in case 2.

Fig 6c Suture of the labial flap with vertical mattress sutures anchored to the periosteum.

Fig 6d Suture of the palatal flap: horizontal compressive sling mattress sutures were added to improve the adaptation of the palatal flap above the palatal bone.

Fig 6e The provisional restorations were cemented with no need for rebasing.

Three weeks after surgery, abutments were definitively reprepared with knife-edge or light chamfer preparation using the soft tissue margin as a guide. No retraction

cords were used. At this time, the area of increased clinical crown length was easily recognizable with chlorhexidine staining. Because the actual position of the soft tissue mar-

gin represented the bottom of the future gingival sulcus, this abutment preparation was performed supragingivally. To avoid trauma to the soft tissue during preparation and

Fig 7 Early temporization in case 1.



Fig 7a Two weeks after surgery, the sutures were removed and an impression of the maxilla was taken to build a new relinable provisional restoration.

Fig 7b Three weeks after surgery at the time of definitive abutment preparation.

Fig 7c Three weeks after surgery, the abutments were definitively prepared with knife-edge diamond bur using the soft tissue margin as a guide.

Fig 7d After abutment preparation, the second provisional restoration was relined.



Fig 8 Early temporization in case 2.



Fig 8a Two weeks after surgery at the time of suture removal. This is when the patient had some esthetic discomfort because of the short temporary crowns and the chlorexidine stains.

Fig 8b Three weeks after surgery, when the definitive abutments were prepared.

Fig 8c Definitive abutment preparation with no trauma in the soft tissue.

Fig 8d Second provisional restoration immediately after being relined.



excessive subgingival positioning of the finishing line after complete soft tissue maturation, care was taken by the clinician to leave some chlorhexidine stain close to the soft tissue margin during abutment preparation. After preparation, the second provisional restoration was relined without any bleeding, and the remaining chlorhexidine stain was cleaned with coppette and prophylaxis paste.

The early provisional restorative phase allowed the early conditioning of the soft tissue profile, optimizing the control of potential rebound for a better esthetic outcome. Over the next 5 to 6 months, further modifications of the convergence of provisional interproximal surfaces and the position of the contact points allowed for maximum regrowth of the interdental papillae. The soft tissue conditioning phase until the

final impression in the two clinical cases is shown in Figs 9 and 10. The first contact points of the provisional restoration were set at a distance of 3 mm from the interdental soft tissue. A new appointment was scheduled for 3 weeks later to check for growth of the interdental papillae, and once the papillae filled the space, the emergence profile of the temporary crowns was modified and the contact points were

Fig 9 Soft tissue conditioning phase in case 1.

Fig 9a Three weeks after surgery, the provisional restorations had open interdental space to be filled by the soft tissue.



Fig 9b Six weeks after surgery, the interdental spaces were filled by papillae. The papillae need further space; the emergence profile of the provisional restorations were modified and the contact points were coronally shifted an additional 1 mm.



Fig 9c Ten weeks after surgery, the papillae completely filled the interdental space.



Fig 9d The temporary crowns were modified to further shift the contact point more coronally by 1 mm.



Fig 9e Four months after surgery, the papillae did not completely fill the interdental space. The contact point and the emergence profile of the provisional restorations were not modified.



Fig 9f At the last control visit, 6 months after surgery, the papillae had not grown significantly since the previous visit. The provisional restorations were not modified, and the tissue was ready for the final impression.

Fig 10 Soft tissue conditioning phase in case 2.

Fig 10a Three weeks after surgery. The second provisional restorations had open interdental space.

Fig 10b Ten weeks after surgery, the papillae grew, and site-specific modifications were made to the provisional restorations to leave further space for the papillae to grow.



Fig 11 Final impression in case 1.

Fig 11a (left) Last provisional restoration with no further growth of the interdental soft tissues.

Fig 11b (right) Soft tissues at the time of the definitive impression procedures.



Fig 12 Final impression in case 2.

Fig 12a (left) Last provisional restoration with no further growth of the interdental papillae.

Fig 12b (right) Soft tissues at the time of the definitive impression.



Fig 13 Definitive zirconia single crown restorations.

Fig 13a (left) Case 1: labial aspect. All interdental spaces were filled with soft tissue even though the contact points between the restorations and between the restorations and the lateral incisors were located more coronal with respect to the contact point between the lateral incisor and the canine, which were natural teeth. This could be ascribed to the conditioning effect on the interdental soft tissue of the early restorations after the crown-lengthening surgical procedure.



Fig 13b (right) Case 2: labial aspect. Good esthetic outcome was seen, as were long papillae filling the interdental spaces in a patient with a more scalloped biotype and long-triangular-shaped teeth.

shifted coronally by an additional 1 mm. Another visit was scheduled for 1 month later. If the papillae filled the interdental space, the temporary crowns were further modified to shift the contact point even more coronally by 1 mm. Further appointments were scheduled 4 and 6 months later, until the final examination visit, which was never sched-

uled prior to 6 months after surgery. Six months after surgery, when most of the postsurgical soft tissue had matured in most patients,³⁹ it was possible to proceed with definitive high-precision material or digital impressions for final restorations. Nevertheless, in some patients, soft tissue maturation may continue significantly even after 6 months. In the

present approach, the time of the final impression was specifically chosen in each patient when there was no further growth of the interdental papillae at the last control visit, with respect to the last contact point of the temporary crowns (Figs 11 and 12). Definitive zirconia single crown restorations of the two clinical cases are shown in Figs 12 and 13.

Discussion

The aim of the study was to provide a standardized approach for the early restorative phase after a crown-lengthening surgical procedure.

Anticipation of the provisional restorative phase immediately after resective surgery was previously proposed.⁸ In this earlier study, the abutments were vertically prepared (feather edge) during crown-lengthening surgery and immediate temporization after apical flap repositioning with preformed or customized acrylic crowns were performed. Some advantages can be ascribed to the present approach. Performing postsurgical preparation at week 3 allows for much more of the tooth structure to be preserved close to the bone crest. The abutment preparation and relining of the temporary crown performed 3 weeks after surgery are easy because they are done supragingivally, in the absence of bleeding, guided by the healed soft tissue margin and in a relaxed patient. Furthermore, the lack of intrasurgical modification of the abutments avoids the need for postsurgical relining of the temporary crowns. This reduces the length of the surgical session, which is beneficial for the patient. The main drawback of the present approach is that the patient remains with short temporary crowns with respect to the soft tissue margin and greater interdental black holes for 3 weeks, withesthetic disadvantages. However, the discomfort related to the surgery and chlorhexidine staining gener-

ally reduces the patient's esthetic expectations in the first weeks immediately after surgery.

With regard to when and how to manage the temporary restorative phase after crown-lengthening surgery, most studies have suggested waiting several months after surgery,¹¹⁻²² and none have provided standardized protocols to follow. Compared to all other approaches that postpone the provisional therapy for several months after surgery, the present approach has the main advantages of allowing soft tissue conditioning during its maximum growing phase and rendering the definitive abutment preparation much easier and less traumatic because of the supragingival compared to intrasulcular preparation, which requires the use of soft tissue retraction cords. Furthermore, in the delayed approach, the period during which short nonesthetic provisional restorations are worn becomes much longer, leading to potential increased patient dissatisfaction.

Many studies¹¹⁻²² have suggested waiting before proceeding with the final prosthetic phase, and most have proposed significant differences between posterior and anterior areas with a longer time to wait for the esthetic zone. In the present approach, the time of the final impression is specifically chosen for each patient, and it is scheduled when there is no further growth of the interdental papillae after the last control visit, with respect to the last contact point of the temporary crowns.

Conclusions

Within the limitations of the present study, some advantages can be ascribed to the present approach:

- The early abutment preparation is easy to perform because it is done supragingivally, using the healed soft tissue margin as a guide.
- The supragingival preparation is not traumatic and does not require the use of retraction cords.
- The early temporization allows for conditioning of soft tissues, especially the interdental papillae, during their maximum growing phase.
- The time for the definitive prosthetic phase is chosen in a patient-specific manner according to the individual potential and duration of soft tissue rebound.

Acknowledgments

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