

Crown Lengthening Procedures- A Review Article

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I. Introduction

Badly mutilated teeth or the grossly decayed teeth often pose problems to the restorative dentists during their treatment due to unavailability of sufficient clinical crowns. Hence a crown lengthening procedure prior to restorative treatment is mandatory during management of such teeth.

Clinical crown lengthening refers to procedures designed to increase the extent of supragingival tooth structure for restorative or esthetic purposes.¹ Clinicians often encounter the need for crown lengthening in the practice of dentistry and have to make treatment decisions taking into consideration how to best address the biological, functional, and esthetic requirements of each particular case.

The concept of crown lengthening was first introduced by D.W. Cohen (1962)² and is presently a procedure that often employs some combination of tissue reduction or removal, osseous surgery, and / or orthodontics for tooth exposure. The amount of tooth structure exposed above the osseous crest (about 4mm) must be enough to provide for a stable dentogingival complex and biologic width to permit proper tooth preparation and account for an adequate marginal placement, thus ensuring a good marginal seal with retention for both provisional and final restorations.³

This article discusses crown lengthening as one way in which the dentist can address both functional and esthetic demands

Indications¹

The indications for crown lengthening are:

- Restorative needs
- To increase clinical crown height lost due to caries, fracture or wear
- To access subgingival caries
- To produce a 'ferrule' for restoration
- To access a perforation in the coronal third of the root
- To relocate margins of restorations that are impinging on biological width.
- Aesthetics
- Short teeth
- Uneven gingival contour
- Gummy smile.

Contra-indications & Limiting Factors⁴

- Inadequate crown to root ratio
- Non restorability of caries or root fracture
- Esthetic compromise
- High furcation
- Inadequate predictability
- Tooth arch relationship inadequacy
- Compromise adjacent periodontium or esthetics
- Insufficient restorative space
- No maintainability

Classification Of Aesthetic Crown Lengthening

Ernesto has proposed the following classification:⁵

CLASSIFICATION	CHARACTERISTICS	ADVANTAGES	DISADVANTAGES
TYPE I	Sufficient soft tissue allows gingival exposure of the tooth without exposure of the alveolar crest and violation of the biologic width.	May be performed by the restorative dentist. Provisional restorations of the desired length may be placed immediately	
TYPE II	Sufficient soft tissue allows gingival excision without	Will tolerate a temporary violation of the biologic width.	Requires osseous contouring. May require a surgical referral.

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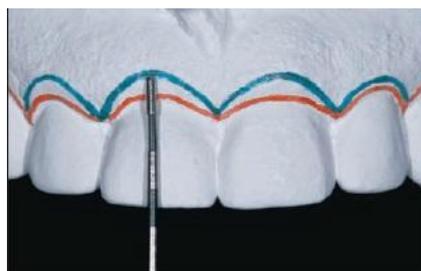
	exposure of the alveolar crest but in violation of the biologic width.	Allows staging of the gingivectomy and osseous contouring procedures. Provisional restorations of the desired length may be placed immediately	
TYPE III	Gingival excision to the desired clinical crown length will expose the alveolar crest.	Staging of the procedures and alternative treatment sequence may minimize display of exposed subgingival structures. Provisional restorations of desired length may be placed at second stage gingivectomy	Requires osseous contouring. May require a surgical referral. Limited flexibility.
TYPE IV	Gingival excision will result in inadequate band of attached gingiva		Limited surgical options. No flexibility. A staged approach is not advantageous. May require a surgical referral.

Type I- It characterized by sufficient gingival tissue coronal to the alveolar crest, allowing the surgical alteration of the gingival margin levels without the need for the osseous recontouring. A gingivectomy or gingivoplasty procedure will usually suffice to establish the desired gingival margin position while simultaneously avoiding the violation of biologic width.

Type II- It is characterized by soft tissue dimensions that allow the surgical repositioning of the gingival margin without osseous recontouring but nevertheless in violation of the biologic width. This type basically consists of staging of crown lengthening procedure in two stages i.e. stage 1 and stage 2. In stage one, a gingivectomy procedure is done and required amount of crown is exposed. Once the tissues are healed stage 2 procedure is done, in which, a flap surgery is done n required amount of ostectomy is done to maintain the biologic width.(Figure 1a-j)



(Fig 1a) Pre operative view of type II case



(Fig 1b) Red and blue lines indicate current and desired gingival margins level.



(Fig 1c) A surgical template is made to provide the periodontist with specific therapeutic parameters with respect to the desired gingival margins and contours.



(Fig 1d) The gingivectomy planned for the first stage is performed on the diagnostic model



(Fig 1e) The diagnostic wax up incorporated the margins levels anticipated following gingivectomy, and will be the basis for fabrication of provisional restorations.



(Fig 1f) Pre operative appearance of the surgical guide during try- in. The amount of soft tissue that will be removed can be easily visualized.



(Fig 1g) Appearance of incisions outlining the gingival collars prior to excision



(Fig 1h) Exposed crown margins and root surfaces after the gingivectomy. While the biologic width spaces have been violated, no osseous exposure has resulted.



(Fig 1i) Type II cases will tolerate a temporary violation of the biologic width. Upon healing, the provisional is optimized until the objectives desired in the final restoration are achieved.



(Fig 1j) The margins of provisional restoration serve as guide during osseous surgery to ensure adequate biologic width space during stage two surgery

Type III- In type III bone sounding may reveal a scenario where repositioning of the gingival margin will result in the exposure of the osseous crest. It is inappropriate to refer these patients without providing a surgical template derived from a relevant esthetic blue print. This template would serve as a guide during surgery so that following flap reflection, a constant relationship between anticipated clinical crown and the osseous crest levels, can be established and maintained through bone cutting procedure. Flaps should also be repositioned coronally, rather than apically, in order to maximize tissue preservation and allow the anticipated revisions to the gingival margins that will follow once the healing from the osseous surgery has been completed. Following adequate healing, a gingivectomy may be performed to establish the definitive gingival position without the risk of violating the biologic width. (Figure 2a-g)



(Fig 2a) Preoperative appearance of type III case



(Fig 2b) A diagnostic aesthetic appliance, which allows a reversible intraoral assessment of the proposed restorative objective



(Fig 2c) The diagnostic template is tried intra orally to determine the post treatment clinical crown lengths while simultaneously recruiting the patients approval



(Fig 2d) The diagnostic appliance serves as a surgical guide during osseous contouring, assuring compliance with the aesthetic blue print and biologic width space.



(Fig 2e) A tension free coronally displaced flap will provide sufficient supracrestal soft tissue to allow gingival margins revisions during provisionalizations.



(Fig 2f) Following adequate healing, a gingivectomy may be performed to establish the definitive gingival position without the risk of violating the biologic width.



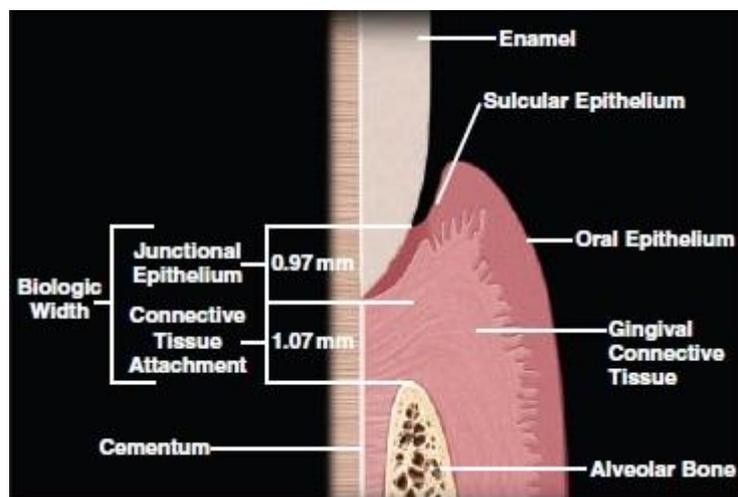
(Fig 2g) With appropriate hemostasis, , soft tissue excision, tooth preparation, provisionals fabrications at the desired clinical crown length may be performed during the same appointment.

Type IV- This type is reserved for scenarios where the degree of gingival excision is compromised by an insufficient amount of attached gingiva. Ideal margin position, therefore, can only be achieved by an apically position mucoperiosteal flap, with or without osseous contouring.

Concept Of Biologic Width²

Biologic Width: Definition, Clinical Relevance, and Violation Consequences

The concept of the biologic width was first originated by research conducted by Gargiulo, Wentz, and Orban where the distance between the apical end of the gingival sulcus and the crest of the alveolar bone was measured on several cadaver specimens.^{6,7} In areas that present with periodontal health, that distance, now regarded as the biologic width, was reported to be an average of 2.04 mm, where approximately 0.97 mm is occupied by the junctional epithelium and 1.07 mm is occupied by connective tissue attachment to the root surface. It has been shown that biologic width is approximately 2mm in 85 percent of population. In approximately 13 percent of the population, the distance exceeds 2mm while the same distance is less than 2mm in 2 percent of the individuals examined.⁸ The physiologic location of the biologic width can vary with age, tooth migration due to loss of arch or occlusal integrity, or orthodontic treatment. (Figure 3).



(Fig 3)

Violation of the biologic width is a common occurrence in the practice of restorative dentistry. A familiar clinical situation in which the biologic width can be violated is by the placement of a deep subgingival restoration. The need to establish a subgingival restorative margin can be dictated by caries, tooth fracture, external root resorption, or the need to increase axial height of a tooth preparation for retention purposes.

If the apical margin of the restorative preparation is placed within the biologic width (i.e., too close to the bone), a zone of chronic inflammation is likely to develop⁹ (Figure 4). One of the theories proposed is that there is insufficient space for a “normal” length of junctional epithelium to develop; the junctional epithelium is short, weak, and does not exert an effective sealing effect of the dentogingival unit.¹⁰ Moreover, the area is easily damaged by mechanical oral hygiene practices, and chronic inflammation persists or is easily induced. Others believe a deeply placed subgingival restorative margin, close to the alveolar bone crest, impairs proper plaque control promoting inflammatory changes not conducive to a healthy periodontal environment.¹¹



Treatment Options For Crown Lengthening Procedures^{12, 13, 14}

Surgical

A Gingivectomy

- Conventional (Scalpel or Kirkland knife)
- Laser
- Electrocautery

B Internal Bevel Gingivectomy with or without ostectomy (also referred as flap surgery with or without osseous surgery)

C Apical positioning of flap with or without ostectomy

Combined (SURGICAL & NON SURGICAL) - Orthodontic Treatment

Surgical

A- Crown Lengthening Surgery Using External Bevel Gingivectomy

This technique is generally performed when there is sufficient sulcular depth and keratinized tissue so that the incision does not violate the biologic width or cause exposure of the bone. It can be performed with the help of scalpel or a Kirkland knife (conventional), lasers or electrocautery.¹²

The incisions are started apical to the point of tissue that is desired to be removed. The incisions are directed coronally. Discontinuous or continuous incisions may be used. The incision should be bevelled approximately 45 degrees to the tooth surface and should recreate, as far as possible, the normal festooned pattern of the gingiva. Then the excised tissue should be removed. Carefully granulation tissue should be curetted out and any remaining calculus or necrotic cementum should be removed so as to leave a smooth clean surface. Finally the area should be covered with a periodontal pack.¹⁴

B- Crown Lengthening Surgery Using Internal Bevel Gingivectomy With Or Without Ostectomy (Undisplaced Flap)¹⁴

It can also be referred as flap surgery with or without osseous surgery.

- **Flap Surgery Without Osseous Surgery :**

To perform this technique without creating a mucogingival problem, the clinician should determine that enough attached gingival will remain after the incisions are made.

The initial or inverse bevel incision is made depending upon that how much crown exposure is required. Then the second or the crevicular incision is made from the bottom of the sulcus to the bone to detach the connective tissue from the bone. The flap is then raised and third incision is given to remove the tissue tags. After complete scaling and root planning flap is then sutured back in position

- **flap surgery with osseous surgery:**

It is the most common procedure used for clinical crown lengthening. A mucoperiosteal flap is designed and raised as described above. The alveolar bone is reduced by ostectomy and osteoplasty, using a combination of rotary instruments and chisels to expose the required tooth length in a scalloped fashion to follow the desired contour of the overlying gingiva. Either a high speed or low speed handpiece with carbide or diamond burs may be used to provide the initial reduction of bone. The bone is reduced close to the tooth, leaving the final removal of bone adjacent to the tooth to hand instruments. The ochsenbein chisel is useful in removing the greatest portion of the thinned bone. The process then is completed with curettes directed against the bone. The final bone level should be measured carefully in all locations around the tooth to be certain that the minimal dimension of 3 to 5 mm of tooth height has been achieved throughout the entire circumference of the tooth. Following flap surgery, a periodontal dressing may be placed to aid in maintaining flap adaptation. Gentle brushing and flossing may begin at 4 to 7 days post surgery or following dressing removal at 7 days post surgery. Chlorhexidine mouth rinse should be used for 4 to 6 weeks to aid in plaque control. Restorative procedures should be delayed until 3 to 6 months post surgery. The longer period reduces the risk for gingival margin shrinkage in areas requiring maintenance of subgingival restoration margin. Provisional restorations may be reshaped at 3 to 4 weeks post surgery but the margins should be placed supragingivally.

C- CIs Using Apically Positioned Flap With Or Without Ostectomy^{14,15}

One of the first authors to describe a technique for the preservation of the gingiva following surgery was Nabers (1954).¹⁶ The surgical technique developed by Nabers was originally denoted "repositioning of attached gingiva" and was later modified by Ariaudo & Tyrrell (1957).¹⁷ In 1962 Friedman¹⁸ proposed the term apically repositioned flap to more appropriately describe the surgical technique introduced by Nabers

The apically positioned flap technique with bone recontouring (resection) may be used to expose sound tooth structure. As a general rule, at least 4 mm of sound tooth structure must be exposed at time of surgery. During healing the supracrestal soft tissues will proliferate coronally to cover 2-3 mm of the root^{19, 20}, thereby leaving only 1-2 mm of supragingivally located sound tooth structure.

Indication: 1- In sites where there is insufficient gingiva for reduction, the initial incision is placed intrasulcularly and a mucoperiosteal flap is raised and apically positioned to gain the needed crown length. 2- Crown lengthening of multiple teeth in a quadrant or sextant of the dentition.¹²

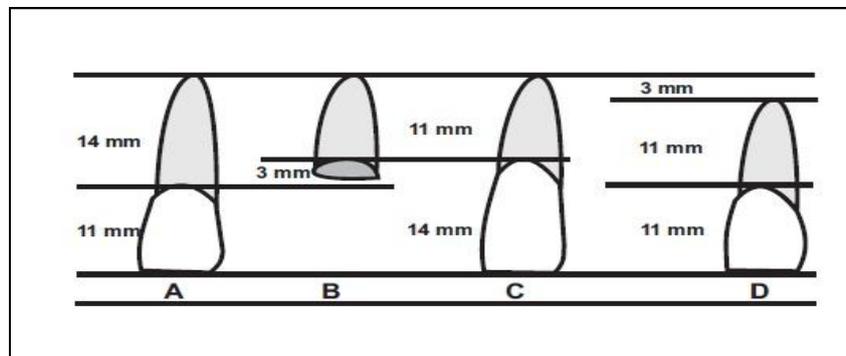
Contraindication: Surgical crown lengthening of single teeth in the esthetic zone.

Technique: According to Friedman (1962)¹⁸ the technique should be performed in the following way: An internal bevel incision is made. To preserve as much of the keratinized and attached gingival as possible, it should be no more than about 1mm from the crest of the gingival and directed to the crest of the bone. The incision is made after the existing scalloping, and there is no need to mark the existing scalloping, and there is no need to mark the bottom of the pocket in the external gingival surface because the incision is unrelated to pocket depth. It is also not necessary to accentuate the scallop interdentially because the flap is displaced apically and not placed interdentially. Then Crevicular incisions are made, followed by initial elevation of the flap, then interdental incisions are performed, and the wedge of tissue that contains the pocket wall is removed. Vertical incisions are then made extending beyond the mucogingival junction. It is important that vertical incisions, and thereafter the flap elevation, reach past the mucogingival junction to provide adequate mobility to the flap for its apical displacement. If the objective is a full thickness flap, it is elevated by blunt dissection with a periosteal elevator. If a split thickness flap is required, it is elevated using sharp dissection with a Bard- Parker knife to split it, leaving a layer of connective tissue, including the periosteum on the bone. After removal of all granulation tissue, scaling and root planning, and performing osseous surgery if needed, the flap is displaced apically. If a full thickness flap was performed, a sling suture around the tooth prevents the flap from sliding to a position more apical than desired, and the periodontal dressing can avoid its movement in a coronal direction. A partial thickness flap is sutured to the periosteum using a direct loop suture or a combination of loop and anchor suture. A dry foil is placed over the flap before covering it with the dressing to prevent the introduction of pack under the flap.

In some cases osseous reduction may be required before placing the flap apically so as to compensate for biologic width and to prevent biologic width violation.

Combined (Surgical And Non Surgical{Orthodontic})

In this technique, orthodontic therapy is done along with surgical technique. Increasing the clinical crown length by orthodontic extrusion is useful when the amount of surgical bone reduction around the affected tooth and adjacent teeth would be excessive. The major advantage of this procedure is the reduced hazard to the adjacent teeth with very little change in crown/root ratio occurs. Orthodontic extrusion for crown lengthening is of prime importance in esthetic zone, because it results in better crown root ratio and improved esthetics than surgical procedure alone as shown in the picture below (Fig 5). The procedure may be contraindicated, however, because of short root length ratio and poor root form, which result in inadequate crown/ root ratio following extrusion.²¹



(Fig 5)- Extrusion versus surgical crown lengthening. The normal anatomic crown root ratio for an average central incisor is 11:14(A). In this example, the tooth is fractured 3.0 mm beyond the cemento-enamel junction (B). Surgical crown lengthening alone would produce an unstable and unesthetic crown root ratio of 14:11 (C). Extrusion followed by crown lengthening produces a more stable crown root ratio of 11:11 with a more esthetic, normal crown length (D).²²

The extrusion can be performed in two ways:¹⁴

- 1- Using LOW ORTHODONTIC FORCE, the tooth can be extruded slowly, bringing the alveolar bone and gingival tissue with it. The tooth is extruded until the bone level has been carried coronal to the ideal level by the amount that will need to be removed surgically to correct the attachment violation. The tooth is stabilized in this new position and then is treated with surgery to correct the bone and gingival tissue levels.
- 2- Second method is by applying RAPID ORTHODONTIC EXTRUSION, where the tooth is extruded rapidly. During this period, a supercrestal fibrotomy is performed weekly in an effort to prevent the tissue and bone from following the tooth. Occasionally, especially with rapid orthodontic extrusion, there is no need for osseous reduction and the soft tissue may be removed by simple excision.²¹ The tooth is then stabilized for at least 12 weeks to confirm the position of the tissue and bone, and any coronal creep can be corrected surgically.¹⁴

Sequence Of Treatment (Allen, 1993)²¹

Clinical and radiographic evaluation

- 1- Caries control
- 2- Removal of defective restorations
- 3- Placement of provisional restorations
 - a. Control of inflammation
 - b. Better assessment of crown lengthening required
 - c. Improved surgical access, especially interproximally
 - d. Enhanced predictability of margin placement postsurgically
- 4- Endodontic therapy
 - a. Precedes surgery
 - b. If not possible, then completion is 4 to 6 weeks postsurgically
- 5- Control of gingival inflammation
 - a. Plaque control
 - b. Scaling and root planing
- 6- Re-evaluation for
 - a. Orthodontic treatment
 - b. Surgical therapy
- 7- Surgery

Presurgical Analysis

Smukler and Chibi (1997)²³ recommended the following presurgical clinical analysis prior to crown lengthening procedures:

- 1- Determine the finish line prior to surgery
- 2- If non determinable, it should be anticipated
- 3- Transcervicular circumferential probing prior to surgery is performed for establishing the biologic width (Bone Sounding)
 - a. Surgical site
 - b. Contralateral site
- 4- The biologic width requirements will determine the amount of alveolar bone removal
- 5- The combination of biologic width and prosthetic requirements determines the total amount of tooth structure necessary for exposure
- 6- Tooth structure topography, anatomy, and curvature are analyzed for determining
 - a. Osseous scallop
 - b. Gingival form

Bone Sounding

The level of the alveolar crest must be determined prior to any considerations regarding aesthetic crown lengthening so as to determine the feasibility, surgical aspects, and treatment sequence

It is done following the administration of a local anaesthesia, a measuring instrument is utilized to puncture and penetrate the mucosa until contact is made with the underlying bone. During this periodontal evaluation, bone sounding assists in determining the level of the alveolar crest and thus the need for osseous contouring^{3, 24}. (Figure 6)



(Fig 6)

Specifically applied to aesthetic crown lengthening, bone sounding is performed in an attempt to determine the location of the alveolar crest, primarily on the labial aspect but additionally including the proximal areas. To this effect, a periodontal probe is inserted into the sulcus and forced to penetrate transgingivally until contact is made with the alveolar crest, perforating the junctional epithelium and gingival connective tissue in the process.

General Tissue Assessment Before Undertaking CIs

Soft Tissue Assessment

Situation 1- If width of attached gingiva adequate (>3mm)-external bevel gingivectomy or internal bevel gingivectomy

Situation 2- If width of attached gingiva inadequate (<3mm)- apically positioned flap

Hard Tissue Assessment

Situation 1- If bone crest is low i.e. more apically – no ostectomy

Situation 2- If bone crest is high i.e. more coronal- ostectomy performed.

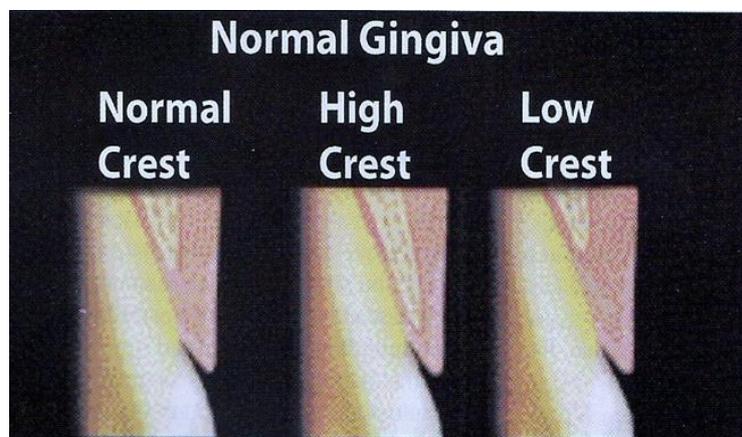
➤ **Bone Crest Levels**

A) Normal crest

B) High crest

C) Low crest

- Low crest unstable- In this situation the Gingival sulcus exaggerated, Bone level is apical , less of attachment and thus less of biologic width
- Low crest stable- In this situation the Gingival sulcus is normal with apical bone levels, more of attachment and therefore more of biologic width. (Figure 7)



(Fig 7)

II. Discussion

Crown Lengthening is a surgical procedure that requires exposure of adequate tooth structure for restorative procedures. Various techniques and methods used for performing Crown Lengthening should be treated in such a way so as to avoid any violation to Biologic Width that can have deleterious effect on periodontium leading to gingival inflammation, loss of attachment and alveolar resorption.

The goal of surgical crown lengthening is to provide the restorative dentist with sufficient clinical crown to permit optimum restoration of a tooth. The indications of surgical crown lengthening are subgingival caries, subgingival fracture, teeth shortened by extensive caries or fracture, naturally short clinical crown due to non exposure of anatomic crown.

The techniques of surgical crown lengthening are:

- a- External Bevel gingivectomy
- b- Internal Bevel Gingivectomy with or without bone reduction
- c- Apically positioned flap with or without bone Reduction
- d- Combined technique (Surgical and orthodontic)

To perform these techniques various criteria are first required to set and then one should choose for an optimal technique which would best suit the situation . All the hard tissue and soft tissue parameters should be recorded first to evaluate the requirement of the case.

There are also various means of performing CLS. For example, Scalpels, Cautery and lasers. It has been seen that healing with lasers is faster than scalpels. Also post operative discomfort is lesser with lasers as compared with scalpels.²⁵

III. Conclusion

Crown lengthening is as a viable procedure that enables to restore teeth having a short clinical crown, extensive subgingival caries, subgingival tooth fractures at dentogingival junction, when performed in ideal clinical conditions, crown lengthening gives satisfactory results both from a functional as well as aesthetic point of view.

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