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Review Paper

Crown Lengthening in Modern Dentistry: Clinical Guidelines and Considerations

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ABSTRACT

A smile greatly impacts perceived attractiveness and confidence. Excessive gingival display, or a “gummy smile,” often results from altered passive eruption (APE) or issues like subgingival fractures. Crown Lengthening Surgery (CLS), introduced by D.W. Cohen in 1962, addresses this by repositioning the gingival margin and removing soft and/or hard tissue. CLS is indicated for prosthetic, esthetic, and restorative purposes. Techniques range from traditional flaps and osseous resection to modern methods like lasers, electrocautery, piezosurgery, and CAD-CAM guided surgery. This review highlights CLS's history, indications, methods, and innovations, emphasizing its key role in dental esthetics and function.

Keywords: Biologic Width, Crown Lengthening, Gingivectomy, Osseous

INTRODUCTION

Preserving natural teeth with optimal function and aesthetics remains a key goal in modern evidence-based dentistry. In cases of structurally compromised teeth, clinicians must conduct a comprehensive, multifactorial risk assessment to guide treatment decisions. Management of such cases might require exposure of additional amount of clinical crown by crown lengthening procedure.

Crown lengthening, introduced by Cohen in 1962, is a well-established surgical technique used to expose additional tooth structure by repositioning the gingival margin and, when necessary, removing bone. This facilitates proper restorative margin placement and ensures the maintenance of biologic width and keratinized tissue essential for periodontal health and long-term restoration success. [1]

The procedure is often indicated when caries or fractures extend below the gingival margin, compromising ferrule effect, esthetics, and restorative access. A minimum of 4.5 mm of supracrestal tooth structure is generally needed, consisting of approximately 2 mm for biologic width and 1.5–2 mm for ferrule.[2] Ingber *et al.* and Sorensen & Engelman emphasize the importance of maintaining biologic width and ferrule to ensure periodontal health and resistance to fracture in restored teeth. [3,4]

Surgical techniques include gingivectomy, apically repositioned flaps (with or without osseous resection), or flapless approaches for tissue preservation. Non-surgical alternatives like orthodontic extrusion and minimally traumatic surgical extrusion have also shown favorable outcomes in select cases.[5] Pontoriero *et al.* demonstrated the importance of adequate healing time after crown lengthening to allow re-establishment of a stable dentogingival complex before final restoration, thereby improving long-term functional and esthetic outcomes.[6] Similarly, studies by Deas *et a*l. and Padbury *et al.* emphasized that respecting biologic width significantly reduces the risk of periodontal breakdown and enhances restorative success.[7,8]

DISCUSSION

The concept of biologic width plays a vital role in maintaining periodontal health and ensuring the long-term success of restorative dental procedures. Biologic width, as defined by Gargiulo *et al*., is the combined epithelial (0.97 mm) and connective tissue (1.07 mm) attachment to the tooth, totaling about 2.04 mm. It represents the soft tissue zone above the alveolar bone. Vacek *et al*. later noted that this width can vary anteroposteriorly from 1.75 to 2.08 mm. [9]

Violation of biologic width triggers bone resorption and inflammation, risking chronic periodontitis. To avoid this, crown lengthening should be done to expose about 3 mm of supra-alveolar tooth structure, along with 1.5–2 mm of ferrule. These dimensions support biologic width reformation, restoration success, and long-term periodontal health. [4] When these are lacking, crown lengthening may be indicated. [2] There are two types: functional (for subgingival damage) and esthetic (to correct excessive gingival display).

Esthetic Crown Lengthening

Smile esthetics play a key role in attractiveness, confidence, and social interaction. A common concern is excessive gingival display, or a "gummy smile," which can disrupt facial harmony. Causes include hyperactive lip muscles, vertical maxillary excess, gingival overgrowth, or altered passive eruption. When due to gingival enlargement or altered eruption, periodontal surgeries like gingivectomy, apically positioned flap, and osseous recontouring can effectively enhance smile esthetics. [7]

Functional crown lengthening

Functional crown lengthening improves restoration retention by exposing more tooth structure, avoiding biologic width impingement, and managing subgingival caries or fractures.

Indications of Crown Lengthening:

- Access subgingival caries
- Create adequate ferrule
- Reposition margins that violate biologic width
- Increase crown height due to caries or fractures
- Access coronal root perforations
- Correct gummy smiles
- Lengthen short clinical crowns
- Improve uneven gingival contours

Contraindications of Crown Lengthening:

- Poor crown-to-root ratio
- Non-restorable teeth
- Severe furcation involvement
- Inadequate restorative space
- Poor tooth alignment
- Close root proximity
- Risk to adjacent anatomical structures
- Poor long-term maintainability
- Compromised esthetics due to the procedure [10]

Pre-surgical Considerations for Crown Lengthening

1. Keratinized gingiva width: Sufficient keratinized tissue is needed to maintain periodontal health and support healing.
2. CEJ or margin-to-bone distance: It determines available tooth structure and whether surgical bone removal is necessary.
3. Periodontal pocket depth: Deep pockets may require treatment before or during crown lengthening for stable results.
4. Crown-to-root ratio: Adequate root length must remain to support the tooth after crown lengthening.

5. Root morphology: Root shape and number affect surgical approach and risk of complications.
6. Proximity to adjacent teeth: Close neighboring teeth limit surgical access and require careful planning.
7. Gingival biotype: Thin biotypes are prone to recession and require more delicate surgical technique.
8. Buccal bone thickness: Thin buccal bone increases risk of bone loss and affects flap design.
9. Supracrestal tissue dimensions: Knowing biologic width guides amount of tissue and bone to remove without causing damage.[11]

Different approaches have been adopted to achieve crown lengthening which includes the following:

Gingivectomy: Gingivectomy, first described by Robicsek in 1884, involves the removal or reshaping of the gum tissue to expose more of the tooth's crown. Gingivectomy procedures can be classified based on the type of incision used:

External bevel gingivectomy: The procedure starts with marking the pockets using either a periodontal pocket marker or a periodontal probe. This ensures precise guidance for the incision and aids in the effective removal of diseased tissue. The external bevel incision is initiated apical to the marked points and is directed coronally at an angle of approximately 45 degree, ending between the base of the pocket and the crest of the alveolar bone. The angulation of the incision is clinically determined by the amount of keratinized gingiva, the height of the alveolar bone crest, and the depth of the periodontal pocket. It is essential to recreate the normal festooning of the gingiva to maintain natural contour and appearance. Once the incision is made, the excised pocket wall is carefully removed. Granulation tissue is thoroughly eliminated, and the root surfaces are cleaned meticulously to facilitate healing and reattachment. A periodontal pack may be placed if necessary to protect the surgical site during the initial healing phase. [12]

Advantages:

- Simple and fast technique.
- No flap reflection required.
- Good visibility and access.
- Predictable soft tissue contouring.
- Minimal post-op complications if proper indications are followed.

Disadvantages:

- Significant tissue removal; not suitable in areas with minimal attached gingiva.
- Does not allow access to underlying bone (no osseous recontouring).
- Open wound healing; greater initial discomfort.
- Risk of violating biologic width if not planned correctly.[13]

Internal bevel gingivectomy: The bevel of the surgical instrument directed apically toward the bone crest, facilitating both soft tissue removal and, when necessary, bone reduction (ostectomy or osteoplasty). Internal bevel incision also known as the first or inverse bevel incision is made using a #15 or #12 surgical blade. This incision is placed 1–2 mm from the gingival margin and directed apically toward the alveolar crest at a 45-degree angle to the tooth surface. It serves to remove the diseased pocket lining and reduce pocket depth while maintaining the integrity of the outer gingiva. Following this, a second crevicular incision is made within the sulcus to detach the tissue from the tooth, and a third interdental incision using an Orban knife removes the remaining tissue collar between teeth. After these incisions, a flap may be elevated to allow thorough debridement of granulation tissue, calculus removal, and root surface planning. The flap is then repositioned and secured with sutures to ensure close adaptation to the tooth and bone surfaces.[12]

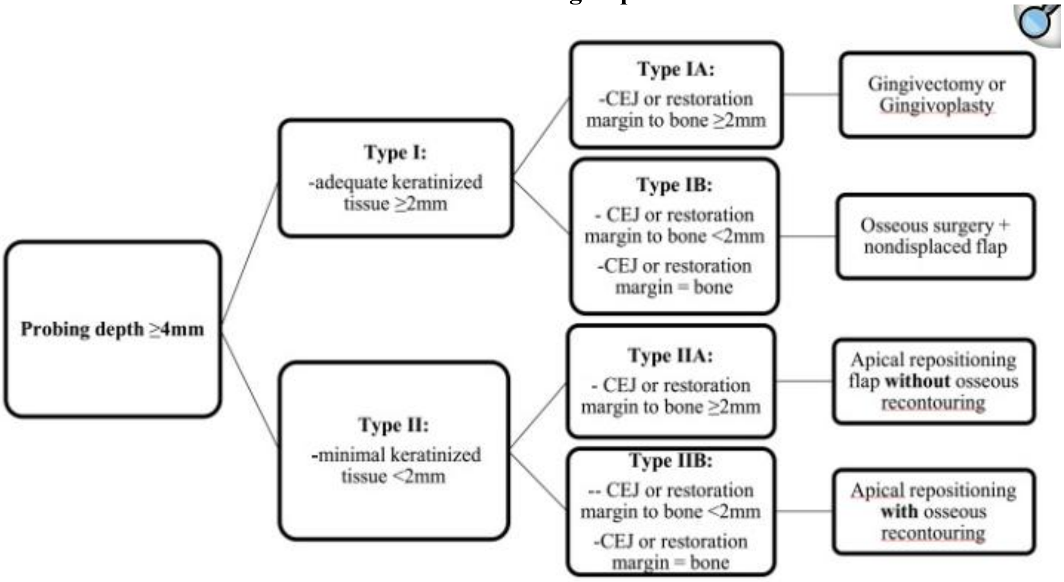
Advantages:

- Better conservation of attached gingiva.
- Allows for simultaneous bone recontouring (flap surgery).

- Primary wound closure faster healing and less discomfort.
- More precise tissue removal under direct visualization.

Disadvantages:
- Technically more demanding.
- Requires flap reflection and suturing.
- Slightly longer surgical time.
- May involve more post-op swelling and pain than external bevel.[14]
- Gingivectomy/gingivoplasty for ≥4 mm probing depth with adequate keratinized gingiva. (Table 1) [14]

Table 1: Probing Depth



Crown lengthening can be achieved through various non-traditional surgical techniques, including chemosurgery, electrocautery, cryosurgery, and laser therapy.

Chemosurgical crown lengthening employs chemical agents, such as 5% ferric sulfate, to selectively remove or cauterize gingival tissue, providing a bloodless and controlled operative field. This technique has been explored as an alternative to conventional surgical methods for managing gingival overgrowth.[5] While this method offers excellent hemostasis and minimizes mechanical trauma, its precision in tissue removal is limited, and there is a risk of collateral damage to adjacent structures. A narrative review by Bandi M *et al.* discusses the clinical applications of ferric sulfate in dentistry, highlighting its efficacy as a hemostatic agent but also noting potential drawbacks such as tissue irritation and staining. The review emphasizes the need for careful application to prevent unintended mucosal damage and underscores the importance of operator expertise in achieving optimal outcomes.[15]

Electrocautery was first proposed by Flocken in 1980. Surgical diathermy is another name for it. It is the division of tissue caused by a high-frequency electrical current administered with a metal tool or needle. It works with 1.5-7.5 million cycles per second high-frequency current. There are three types of electrodes used: the loop for cutting and coagulating larger areas, the needle for fine, precise cutting and the ball for coagulation of delicate or broad tissue. [5]

This technique uses heat generated by electric current to excise gingival tissue, offering effective hemostasis but posing a risk of collateral thermal damage to surrounding tissues. Polson and Caton's study demonstrated that thermal injury to cementum adversely affects connective tissue adhesion, indicating that such damage compromises the biological compatibility of the root surface. When applied with appropriate technique, electrocautery can improve surgical precision and efficiency in crown lengthening procedures.[16] However, as emphasized in a review by Bashetty K *et al.,* electrosurgery should be limited to well-established indications in soft-tissue surgery, underscoring the necessity of proper technique.[17]

Cryosurgery involves the application of extreme cold (typically liquid nitrogen) to destroy targeted soft tissue, which minimizes bleeding but requires careful control to avoid excessive tissue necrosis. This technique has been shown to be effective in a variety of clinical settings. A study by Baust *et al.* highlighted that cryosurgical procedures can induce apoptosis and necrosis selectively in targeted tissues while preserving surrounding structures when properly controlled. It is indicated in cases of gingival overgrowth or hyperplasia, esthetic crown lengthening (soft tissue only), patients with bleeding disorders, medically compromised patients. [18] Hegde *et al.* in his study pointed out *that* minimally invasive surgical methods like cryotherapy can be beneficial in patients where conventional surgery is contraindicated or presents a high risk. It reduces systemic stress and facilitates smoother recovery. [19]

Laser assisted crown lengthening, offers excellent precision, minimal bleeding, and faster healing, making it increasingly popular in modern periodontal and restorative practices. The laser technique varies depending on the device and the wavelength of the laser used. The more the ablation of the tissue, the greater the absorption of laser energy in the target tissue. The amount of tissue to be removed usually determines which approach is optimal for removing tissue. When a considerable amount of tissue needs to be removed, an excisional approach is performed. When only a little quantity of tissue needs to be removed, ablation is usually the best option. The laser light is delivered in a back-and-forth motion to ablate (vapourize) the tissue in small areas during this procedure. Selection of laser mainly depends on the effect of laser on the adjacent tissues. Carbon dioxide (CO_2) and Nd:YAG, Argon lasers with wavelengths of 10,600nm and 1064nm, respectively, are the most often utilised soft tissue lasers in dentistry. Its advantages include operating field can be achieved, reduced chances of bacteremia due to instant sterilization of the operating field, improved healing, decreased post-operative edema and scar formation, decreased post-operative pain and discomfort.[20] Clinical studies support these benefits; for instance, Romeo *et al.* demonstrated that diode lasers provide effective soft tissue management with reduced postoperative discomfort and inflammation. [21] Additionally, Kamma *et al.* reported that CO_2 lasers allow precise ablation with excellent hemostasis and minimal thermal damage to adjacent tissues. Each modality has unique advantages and limitations based on clinical needs and operator expertise. [22]

Apically Positioned Flap with/without Osseous Resection

This technique is ideal when the bone crest is <3 mm from the intended gingival margin. An internal bevel incision is made 1–2 mm from the gingival margin, followed by a crevicular incision to detach the tissue collar. A full-thickness mucoperiosteal flap is reflected to expose the underlying bone. Granulation tissue is removed, and root surfaces are debrided thoroughly. If indicated, osseous resection (osteoplasty or ostectomy) is performed to reshape the alveolar bone, using tools like rotary burs or piezoelectric devices and establish positive architecture. The flap is then repositioned apically and sutured in place, ensuring proper adaptation and coverage of the alveolar crest. The technique allows precise modification of bone and soft tissue, preventing relapse of biologic width and ensuring stable crown exposure. Proper bone contouring supports long-term esthetic and periodontal stability. Tissue rebound of ~3 mm may occur, especially if the flap is sutured too coronally.[23] A study by Zamet *et al*. compared various periodontal surgical techniques and found that while apically positioned flap with osseous recontouring effectively reduced pocket depths, it could lead to significant alterations in tissue contours, potentially affecting adjacent teeth. [24]

Advantages

- Expansion of attached gingiva zone
- Primary intention healing
- Coverage of alveolar bone
- Controlled postoperative gingival levels
- Maintenance of mucogingival complex

Disadvantages

- Increased surgical time and complexity
- Greater post-operative discomfort and healing time
- Not suitable for areas where bone preservation is critical (e.g., aesthetic zones or in preparation for implants)
- Limited effectiveness in cases with osseous defects or irregular bony architecture
- May not sufficiently reduce deep periodontal pockets
- Risk of relapse if bony defects are left uncorrected [25]

Forced Eruption

Orthodontic extrusion treats compromised teeth conservatively by avoiding excessive bone removal. After orthodontic brackets or buttons are bonded to the tooth, light continuous extrusive forces are applied using elastic chains or springs attached to an archwire or anchorage unit. The extrusion rate is typically 1–2 mm per week to encourage coronal movement of the tooth without significant bone or gingival migration. In some cases, a supracrestal fiberotomy is performed periodically to prevent soft tissue and bone from following the tooth coronally. Once the desired extrusion is achieved, the tooth is stabilized for 4–6 weeks to allow for periodontal reorganization before final restorative treatment. Slow extrusion moves the tooth and tissues coronally, often followed by minor bone reshaping, while rapid extrusion moves only the tooth using stronger forces and weekly fibrotomy, typically avoiding surgery. The timing of crown lengthening depends on crown height, esthetic goals, and treatment sequencing. [26] According to Robbins JW *et al*., when teeth are severely crowded or rotated, placing orthodontic brackets may be difficult, and crown lengthening performed before orthodontic treatment can improve access for bracket placement. However, this may require additional gingival refinement after orthodontics to ensure ideal contours. In cases where hygiene becomes compromised during orthodontic therapy, mid-treatment surgery may be beneficial.[27] Montevecchi M *et al.* emphasize that a 6–12 week stabilization period is essential, allowing bone maturation and preventing relapse. [28]

Advantages

- Preserves alveolar bone and periodontal support
- Avoids excessive osseous resection
- Improves crown-root ratio before restoration
- Maintains or improves soft tissue architecture
- Suitable for aesthetic areas

Disadvantages

- Time-consuming (requires weeks to months)
- Requires patient compliance
- May need multiple procedures (e.g., fibrotomy, minor surgery)
- Not suitable if root length is insufficient for extrusion
- Relapse risk if not properly stabilized [26]

Surgical Extrusion

Used for teeth with deep fractures or caries, surgical extrusion involves repositioning the tooth coronally using periotomes or elevators. It's ideal in aesthetic zones, offering functional and cosmetic benefits, but requires careful handling to avoid root resorption. Plotino *et al*. in his study highlighted that surgical extrusion is a viable alternative to extraction for teeth with crown–root fractures, cervical root fractures, and subgingival caries, emphasizing its conservative approach in maintaining surrounding structures. [29] A periotome is carefully inserted into the periodontal space. The instrument is gently advanced circumferentially along the root surface, severing the PDL fibers with minimal trauma. Straight periotomes are best suited for anterior teeth, allowing precise severance of the PDL in narrow spaces. Angled periotomes are preferred for posterior teeth, offering enhanced access to deeper periodontal regions. Once the tooth is adequately loosened using a periotome, controlled extrusion is carried out using extraction forceps with a firm apical grip, applying slow, vertical traction without rocking. In certain cases, an elevator or a similar instrument may be used, depending on root anatomy and access. The tooth is carefully extruded by 2–4 mm, ensuring minimal trauma. It is essential to avoid root fracture, protect the alveolar socket, and monitor for any excessive resistance during the procedure. Sometimes intentional reimplantation can be used to expose fracture lines or subgingival caries. Intentional reimplantation is used for single-rooted permanent teeth with fractures or deep decay near the bone. The tooth is atraumatically extracted using periotomes and luxators to preserve the periodontal ligament and surrounding bone. Typically, in such cases, the labial fracture line is located paragingivally or supragingivally, while the palatal defect extends infraosseously. Given that the palatal alveolar bone is positioned more coronally than the labial aspect, rotating the root by 180 degrees before reimplantation helps expose the defect margin more evenly, reducing the required extrusion distance.[30]

A clinical study by Caliskan MK *et al.* analyzed 20 cases on intentional reimplantation. The study found favorable outcomes. [31]

Advantages

- Immediate results (single-stage procedure)
- Preserves natural tooth and alveolar bone
- Avoids lengthy orthodontic treatment
- Useful in aesthetic zones for functional and cosmetic outcomes
- Facilitates proper ferrule effect for restorations

Disadvantages

- Risk of root resorption or ankylosis
- Potential for root or alveolar fracture during procedure
- Requires delicate technique and surgical expertise
- May need splinting post-operatively
- Not suitable for teeth with short roots or poor periodontal support [30]

Guided Crown Lengthening

Guided crown lengthening is a digitally planned periodontal surgical procedure aimed at increasing the amount of exposed tooth structure for restorative or esthetic purposes. It is particularly useful in cases involving subgingival caries, fractured teeth, short clinical crowns, or excessive gingival display (gummy smile). Unlike conventional methods, guided crown lengthening utilizes a digitally designed surgical guide created from the patient's intraoral scan and CBCT data. This guide reflects the ideal future crown margin and helps ensure precise soft and hard tissue modification. The process begins with digital treatment planning, where a diagnostic wax-up defines the desired final tooth contours. Using this data, a surgical guide is fabricated to indicate the location of the proposed gingival margin and the extent of bone removal needed to re-establish the biologic width typically 3 mm between the crown margin and the alveolar bone crest.

During surgery, a full-thickness flap is reflected to expose the underlying bone, which is then contoured according to the guide. After the osseous recontouring, the flap is repositioned and sutured, usually slightly coronal to the new bone level. The guided approach increases precision, reduces intraoperative guesswork, enhances interdisciplinary communication, and yields predictable esthetic and functional outcomes. It is especially valuable in the esthetic zone, where symmetry and soft tissue contours are critical. [32] A study by Coachman C *et al.* concluded that the double guide for surgical crown lengthening allows the proper management of hard and soft tissues for achieving a predefined goal based on biological requirements and facially driven planning. In addition, the digital quality control allows the follow-up compared with the pre-operative condition and planned treatment.[33]

CONCLUSION

Crown lengthening techniques should be chosen based on individual factors like biologic width, tooth structure, bone condition, and treatment goals. Functional crown lengthening improves restoration success, while aesthetic procedures enhance smile appearance, especially in the anterior maxilla. A thorough periodontal assessment ensures accurate diagnosis and a predictable, goal-oriented treatment plan.

Declaration by Authors

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