



## The Important Considerations and the Clinical Assessment Proceeding Crown Lengthening Surgery: Revisited Review

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### Abstract

Crown lengthening Surgery (CLS) is the most common periodontal surgical procedure. In this review, we aimed to emphasize on important considerations proceeding CLS such as: Biological width, Tissue phenotype, Root furcation and timeframe before definitive restoration. In addition, to spotlight on the pre-surgical clinical assessment that should be performed in conjunction with the regular periodontal examination (GI, PI, PD, mobility & root function) proceeding CLS procedure. Which includes: tooth width-to-height proportionate, smile line, altered passive eruption (APE) diagnosis, tissue phenotype and amount of keratinized gingiva (KG).

**Keywords:** Crown Lengthening Surgery (CLS); Short Clinical Crown (SCC); Altered Passive Eruption (APE); Gingival Phenotype (GP); Keratinized Gingiva (KG)

### Introduction

Preservation of healthy periodontium is necessary for the long-term success of restored dentition. The biologic, restorative and esthetic requirements of the teeth must be balanced throughout the periodontal surgical procedure. Crown lengthening surgery (CLS) described as surgical removal of hard and soft periodontal tissues to establish supra-crestal tooth length, allowing for a longer clinical crown [1,2]. The basic biologic concept for CLS is to create an adequate space for the supra-crestal soft tissue attachment between the base of sulcus and the crest of the alveolar bone which referred to "Biological width" [3]. CLS is often required to manage the restorative and the aesthetic challenges of dentition inflicted by short clinical crown condition (SCC) [2].

A short clinical crown (SCC) is basically defined as a tooth with less than 2 mm of sound opposing parallel walls remained after occlusal and axial reduction [4]. Excessive carious lesion altered passive eruption (APE), para-functional habit/tooth wear and

traumatic injury (crown/root fracture) are the main contributing factors of a SCC condition [2]. Gummy smile is a common aesthetic concern that may be caused by altered passive eruption (APE) [5]. Understanding the different diagnosis of APE is crucial as the diagnosis could dictate the type of CLS treatment selected. Two main types of CLS are presented, pre-restorative and esthetic CLS treatments. The decision on which type of CLS treatments to select can only be attained through a meticulous clinical assessment.

When CLS is indicated, Important considerations should be defined and documented such as, biological width, tissue phenotype, root furcation and timeframe before the definitive restoration. Each of these considerations is a vital determinant of the post-surgical treatment outcome. Therefore, in this review we aimed to emphasize on these biologic considerations and to address an important pre-surgical clinical assessment proceeding CLS treatment. An electronic search through Google Scholar of all the published studies from any epidemiologic designs have been made, up to the time

of writing this review. We included those studies that have open access and have been written in English Language. Several Medical Search Headings (MeSH) have been used in this search, such as: crown lengthening, biologic width, post-surgical healing, root furcation, altered passive eruption, tissue biotype and gummy smile.

**Important considerations from the literature**

**Biological width:** The term biological width defined by Gargiulo as a summation of the junctional epithelium and the supra-crestal connective tissue attachment. An average length of epithelial attachment (0.97 mm) combined with the average length of the connective tissue attachment (1.07 mm permits 2.04 mm overall dimension of biologic width [3]. The biologic width acts as a physiological barrier that protect periodontal attachment and the supporting alveolar bone [6]. Placing restoration margins within the biologic width often leads to gingival inflammation, clinical attachment loss and alveolar bone resorption [7]. Amount of the distance required to restore biological width between restorative margin and the alveolar bone crest still subjected to controversy [8-10]. However, in general 3 mm of supra-crestal tooth structure must be maintained, allowing 2 mm for biological width and 1 mm for restorative finish line.

**Tissue phenotype:** The term gingival phenotype (GP) described the thickness of the gingiva at facia-palatal/facia-lingual direction [11,12]. Seibert and Lindhe classified GP as thin scalloped and thick flat [13]. A thin GP may present scalloped osseous contour, narrow teeth contacts, and triangular crowns. A thick GP may present thick flat osseous contour, broad teeth contacts, and square crowns [14]. Claffey described thin GP as gingival thickness (GT) of < 1.5 mm and thick GP as GT > 2 mm [15]. Periodontal phenotype consists of not only GT, but alveolar bone thickness, amount of keratinized gingiva (KG) and crown shape as well [16,17]. Lang and Loe suggested a minimum amount of 2 mm of KG required for a healthy periodontium [18]. A thin GP tends to be common in youths and in women [19]. In general, a subject with thin GP is more susceptible to aesthetic complications (attachment loss and marginal recession) following CLS treatment [20]. Thus, careful assessment of tissue phenotype should proceed CLS treatment particularly in the anterior region.

**Root furcation:** CLS treatment in multi-rooted tooth exhibits greatest challenges as furcation involvement known to compromise tooth prognosis [21]. In literature, several classification of

furcation involvements are presented; however, Glickman is the most frequently used on daily bases [22] (Table 1). Clinical and radiographic assessments of furcation entrance in relation to root trunk should proceed CLS treatment. According to Dibart, the distance between restoration margin and furcation entrance defined as a critical distance from furcation (CDF) and should not be less than 4 mm [23]. Thus, as a guideline, if tooth destruction invades the CDF, CLS may not be the preferable treatment, and other alternative may be considered (root resection).

Classification	Criteria
Grade I	Incipient
Grade II	Loss of interradicular bone and pocket formation, but not extending through to the opposite side
Grade III	Through and through lesion
Grade IV	Through and through lesion with gingival recession, leading to a clearly visible furcation area

**Table 1:** Glickman furcation classification.

**Healing Period after Crown Lengthening Surgery(CLS):** After CLS treatment, remodeling and complete stabilization of periodontal tissues require an adequate time period. Studies reported amount of 0.6 - 0.8 mm of bone loss occurs with each time flap being reflected [24,25]. Due to this fact, it is difficult to predict the final position of periodontal soft and hard tissues. In addition, other factors may negatively influence the aesthetic outcomes like, surgical trauma, flap management technique and thin GP [26-28]. A study by Bargger, *et al.* reported 12% of surgical sites exhibit 2 - 4 mm gingival recessions between 6 weeks to 6 months period following CLS treatment [29]. Thus, in aesthetic areas, a close observation of gingival alteration must be obtained during the healing period.

Re-establishment of biological width to its original vertical dimension following CLS treatment has been investigated in the literature [30,31]. A systemic review suggested that complete tissues remodeling and biological width re-establishment may require at least 6 months following CLS treatment [32]. Therefore, final cementation of the definitive restoration must be performed after complete stabilization of periodontal tissues which only occur at 6 months period following CLS treatment [27,28].

**Types of crown lengthening surgery (CLS)**

CLS treatment is classified into two main types based on the diagnosed condition and the treatment purpose; pre-restorative

and aesthetic CLSs. However, the surgical procedure for both types remains similar. It involves either gingivectomy or apically positioned flap (APF) with/out osseous reduction or combination of both procedures:

1. Pre-restorative CLS treatment: Mainly performed in two clinical situations, first: presence of deep subgingival tooth destruction (carious lesion, crown root fracture line or cervical erosion) and the restorative dentist unable to locate restoration margins. Second: presence of inadequate remaining tooth structure to provide the required retention form for a cast restoration. Noteworthy, special aesthetic consideration must be undertaken if pre-restorative CLS treatment indicated in the anterior region of maxilla. For example, in a single anterior tooth situation, post-surgical mismatch in the gingival contour between neighboring teeth may compromise the aesthetic outcome. In this case, other alternative treatment may be considered (orthodontic extrusion).
2. Aesthetic CLS treatment: Mainly indicated to eliminate the excessive gingival display (gummy smile) and to achieve ideal gingival symmetry and tooth length.

**Gummy smile**

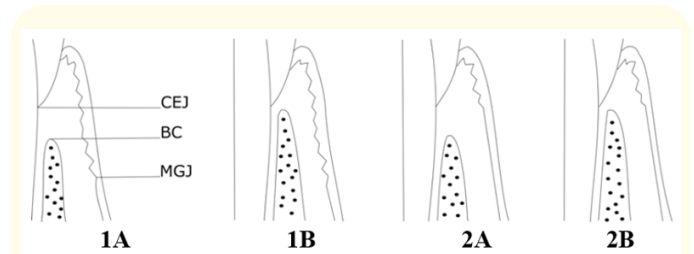
Gummy smile or excessive gingival display is often aesthetically unpleasing. It affects 10% of young population, more prevalent in women and tend to decrease with age [33]. Liébart classification has been proposed to diagnose excessive gingival display condition [34].

Classification	Criteria
Class 1	Very High Smile Line, > 2 mm of marginal gingiva visible or > 2 mm apical to the CEJ visible for the reduced but healthy periodontium (gummy smile).
Class 2	High Smile Line, 0 to 2 mm of marginal gingiva visible or 0 to 2 mm apical to the CEJ visible for the reduced but healthy periodontium.
Class 3	Average Smile Line, gingival embrasures only visible.
Class 4	Low Smile Line, gingival embrasures and CEJ not visible

**Table 2:** Liébart classification.

**Etiology:** Understanding the causes of gummy smile is the key principle. It may caused by skeletal (vertical maxillary growth), dental (maxillary dento-alveolar extrusion), muscular (hypermobility of upper lip, short lip) or gingival (APE) factors [5], which may occur alone or in combination.

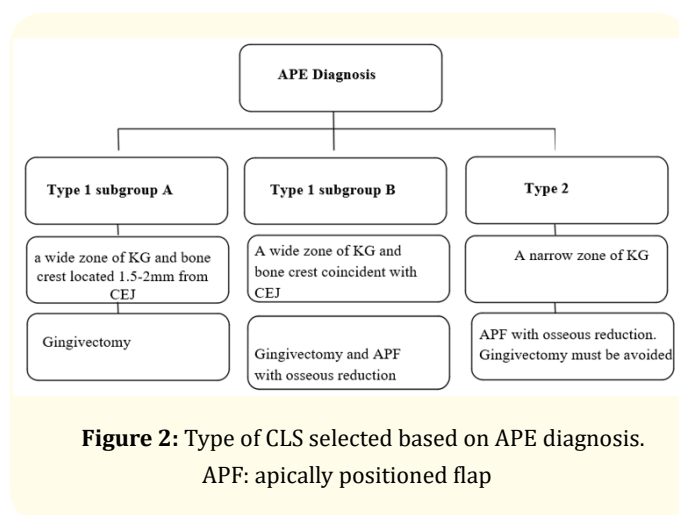
Altered passive eruption (APE) is the most common cause of gummy smile. Goldman and Cohen defined APE as a condition in which “the gingival margin in adult located incisal to the cervical convexity of the crown and removed from cemento-enamel junction (CEJ) of the tooth [35]. Failure to conclude the passive eruption phase may be caused by genetic and development condition. A probing depth over 3 mm with no sign of inflammation(pseudo-pocket) may indicate APE [36,37]. However, according to Coslet, the definitive diagnosis of APE could only be reached based on three detrimental positions. Position of free gingival margin (FGM) in respect to CEJ (pseudo-pocket), position of muco-gingival junction (MGJ) in relation to bone crest and position of bone crest in respect to CEJ [38].



**Figure 1:** Coslet classification.

Classification	Criteria
Type 1	The free gingival margin (FGM) is incisal or occlusal to the CEJ and the mucogingival junction (MGJ) is apical to the bone crest (wide keratinized gingival band)
Type 2	The free gingival margin (FGM) is incisal or occlusal to the CEJ and the mucogingival junction (MGJ) coinciding at the level of CEJ (narrow keratinized gingival band)
<b>Two sub-classes referred to position of bone crest in relation to CEJ</b>	
Subgroup A	The alveolar crest is located 1.5 - 2 mm from the CEJ
Subgroup B	The alveolar crest is coincident with the CEJ

**Table 3:** Coslet classification of APE.



### Pre-surgical clinical assessment

For a successful CLS treatment outcome, a meticulous pre-surgical clinical assessment should be performed, which includes: tooth width to-height proportionate, smile line, APE diagnosis, gingival biotype and amount of KG. In addition to the regular periodontal examination (plaque and gingival indices (PI and GI), probing depth (PD), mobility and root furcation) that must be performed as well.

### Assessment of tooth width to-height proportionate

Measurement of the size and key proportion of natural tooth is an important parameter for a desired aesthetic outcome. Ward developed a new set of tooth proportionate value to design a smile that balanced with the face. According to Ward, the preferred width-to-height ratio of the maxillary anterior teeth is between 66% - 80% [39]. Today, this ratio has gained a general acceptance among dentists as an ideal tool for smile design.

### Assessment of smile line

Evaluation of smile line must be done during natural and forced smiles (Table 2).

### Assessment of APE diagnosis

To reach an accurate diagnosis of APE, clinical and radiographic examination must be performed to determine the following: 1-Position of CEJ of an individual tooth using periodontal probe. 2-Position of MGJ in relation to bone crest which can be achieved by the trans-gingival technique (for bone crest) and by the visual, func-

tional and iodine stain methods (for MGJ). 3-For sub-groups diagnosis of APE, a bitewing's radiograph must be taken to determine position of bone crest in relation to CEJ].

### Assessment of the gingival phenotype (GP)

- **Visual inspection method:** A classification of GP based on inspection of tooth shape, KG and the interdental gingiva. This method is simple and the most popular used, but it exhibits less valid records [40].
- **Periodontal probing method:** The probe inserted into the gingival sulcus and based on the probe transparency, GP determined; thin (visible probe) or thick (invisible probe) [41]. This method is simple, reproducible with 85% inter-examiner repeatability [13]. However, some challenges in pigmented gingiva may exist.
- **Trans-gingival method:** The probe inserted perpendicularly on the mid-position between the FGM and the MGJ and the diameter of the GT can be measured by the probe. Thin GP: GT < 1.5 mm or a thick GP: GT > 1.5 mm [42]. This method is invasive must be performed under local anesthesia; however, it shows reliable records [43].
- **CBCT method:** Highly accurate, allows measurement of GP in millimeters, however the cost and radiation exposure may limit its use for this purpose [44,45].
- **Ultrasonic device method:** An ultrasonic device introduced by Muller to assess GP, it shows reliable records; although, it subjected to some errors [46].

### Assessment of the amount of keratinized gingiva (KG)

Clinically, amount of KG measured from FGM to the MGJ using periodontal probe [47]. Thus, MGJ line is an important land mark that distinct between the immobile tissues (KG) and the mobile tissues (alveolar mucosa). MGJ line and the amount of KG can be determined by three methods [48]:

- **Visual inspection method:** By direct inspection of color differences from keratinized mucosa (immobile tissue) to non-keratinized gingiva (mobile tissue).
- **Functional method:** By assessment of tissue mobility through running the probe on horizontal direction and with light pressure, from the vestibule (mobile tissue) toward FGM (immobile tissue) [49].

- **Iodine solution method:** By staining the tissue with iodine that known to be sensitive to glycogen content. Alveolar mucosa contains increased amount of elastic fibers and glycogen contents. After staining, tissue assessed by visual inspection of color contrast based on glycogen content between alveolar mucosa and keratinized mucosa.

However, studies revealed no significant difference in KG measurements among the three methods [48].

## Conclusion

CLS treatment is frequently used on daily bases to manage both restorative and aesthetic complications of the teeth created by SCC condition. Consideration of the biologic features of the dentition (biological width, tissue phenotype, root furcation and healing time) proceeding CLS treatment, is of extreme importance. Neither the visual inspection alone nor the regular periodontal examination (GI, PI, PD, mobility and root furcation) is an adequate to evaluate and diagnose a tooth with SCC condition. However, a meticulous pre-surgical clinical assessment that includes, tooth width to-height proportionate, smile line, APE diagnosis, gingival phenotype and amount of KG, beside; regular periodontal examination is utmost and the key principle for successful post-surgical outcomes.

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