

Aesthetic Crown Lengthening Using Chu Aesthetic Gauges for Management of Excessive Gingival Display: A Three-Case Series

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Abstract:

Background: Excessive gingival display can compromise smile aesthetics by creating an imbalance between visible tooth structure and gingival tissues. Aesthetic crown lengthening is a periodontal surgical approach used to increase clinical crown exposure and establish a harmonious gingival contour. Precise determination of the desired gingival margin is essential for achieving predictable aesthetic results, particularly in the maxillary anterior region.

Aim: To evaluate the clinical effectiveness of Chu aesthetic gauges in achieving predictable gingival margin positioning and harmonious clinical crown proportions during aesthetic crown lengthening in patients with excessive gingival display.

Materials and Methods: A descriptive three-case series was conducted in three systemically healthy female patients aged 22, 24, and 25 years who presented with excessive gingival display and short-appearing maxillary anterior teeth. Aesthetic crown lengthening was planned in the maxillary anterior region from 13 to 23. The Chu aesthetic gauge was used for assessment and treatment planning to determine desired clinical crown proportions and gingival margin position. The surgical procedure involved gingival excision followed by periodontal flap elevation, debridement, osseous reduction, flap repositioning, and suturing. Clinical crown length, transgingival probing measurements, and marginal gingival levels were assessed at baseline and during follow-up. Postoperative pain was evaluated using the Visual Analogue Scale (VAS), and patient satisfaction was assessed during follow-up.

Results: Following treatment, an increase in clinical crown length and favorable apical repositioning of the gingival margin were observed in all three cases. Mean clinical crown length increased from 6.5 mm at baseline to 8.5 mm postoperatively and 9.5 mm during follow-up. Mean transgingival probing measurements changed from 4.65 mm at baseline to 3.33 mm postoperatively, 3.0 mm at 1 month, and 3.5 mm at 3 months. Mean marginal gingival level changed from 4.5 mm at baseline to 2.5 mm postoperatively, 2.33 mm at 1 month, and 3.33 mm at 3 months. Postoperative pain was generally mild and decreased during follow-up. All three patients demonstrated satisfactory aesthetic outcomes and favorable patient satisfaction.

Conclusion: Within the limitations of this three-case series, Chu aesthetic gauges provided a systematic and clinically useful approach for determining gingival margin position and achieving harmonious clinical crown proportions during aesthetic crown lengthening. The technique resulted in favorable aesthetic outcomes, increased clinical crown exposure, and satisfactory patient-reported outcomes. Further studies with larger sample sizes and longer follow-up are warranted to establish the predictability and long-term stability of this approach.

Keywords: Aesthetic crown lengthening; Chu aesthetic gauge; excessive gingival display; gummy smile; gingivectomy; clinical crown length; gingival margin; periodontal surgery.

I. INTRODUCTION

Smile aesthetics represents an important component of contemporary periodontal and restorative dentistry. The appearance of the smile is influenced by the relationship between the teeth, gingiva and lips, and even minor discrepancies in gingival architecture can become conspicuous in the maxillary anterior region. Excessive gingival display, commonly described by patients as a “gummy smile,” may result in an apparent reduction in the clinical crown length and an altered tooth-to-gingiva relationship. Depending on its underlying cause, management may involve periodontal, restorative, orthodontic, surgical or combined treatment modalities. Aesthetic crown lengthening is one of the periodontal procedures used to increase the amount of visible tooth structure and improve the harmony of the dentogingival complex.^{1,2}

Crown lengthening may be performed for functional or aesthetic indications. Functionally, it may be indicated when additional tooth structure is required for restoration of teeth affected by subgingival caries, fractures or inadequate clinical crown height. In the aesthetic zone, however, the principal objective is frequently modification of the gingival margin and exposure of an appropriate amount of anatomical crown. In patients with altered passive eruption or excessive gingival display, the gingival margin may remain positioned coronally on the anatomical crown, producing a short-tooth appearance despite an otherwise healthy periodontium.³ Successful aesthetic crown lengthening requires considerably more than simple removal of excess gingival tissue. The clinician must determine the desired final gingival margin, evaluate the position of the alveolar crest, assess the available keratinized and attached gingiva, establish appropriate tooth width-to-length proportions and maintain periodontal health throughout the procedure. Diagnostic casts, clinical photographs, periodontal examination and transgingival probing can therefore be valuable components of treatment planning.^{2,3}

A fundamental consideration during crown lengthening is the relationship between the alveolar crest and the dentogingival soft tissues. The term biologic width traditionally refers to the combined dimensions of the connective tissue attachment and junctional epithelium coronal to the alveolar crest. Ingber et al. emphasized the importance of maintaining adequate space between the restorative margin and alveolar crest to preserve periodontal health.⁴ Vacek et al. subsequently demonstrated considerable individual variation in the dimensions of the dentogingival junction, emphasizing that these measurements should not necessarily be regarded as fixed values in every patient.⁵ Kois further described variations in the dentogingival complex according to facial and interproximal locations.⁶

Violation of the supracrestal periodontal tissues during restorative or surgical procedures may be associated with inflammation, alteration of the gingival margin and bone remodeling. Consequently, the position of the alveolar crest must be considered when determining the extent of crown lengthening. Transgingival probing or bone sounding provides a clinical method of determining the relationship between the gingival tissues and underlying alveolar bone before surgical intervention.^{2,5}

Another important factor is the final proportion of the clinical crown. Traditionally, clinical determination of the ideal tooth dimensions has relied substantially on visual estimation, diagnostic wax-ups or templates. Stephen J. Chu introduced a biometric approach that uses specially designed aesthetic gauges to objectively assess tooth dimensions and discrepancies in clinical crown proportions.⁷ The Chu proportion gauge uses colour-coded markings to assist the clinician in assessing the relationship between tooth width and length. The concept was subsequently applied specifically to aesthetic crown lengthening in the midfacial region and to interdental considerations.^{8,9}

The Chu aesthetic gauge system provides a sequential approach rather than relying exclusively on subjective visual judgment. The system includes a proportion gauge, sounding gauge and crown-lengthening/biologic periogauge. The sounding gauge can be used to establish the level of the alveolar crest; the proportion gauge assists in determining the desired clinical crown dimensions; and the biologic periogauge can be used intraoperatively to relate the desired clinical crown length to the underlying periodontal structures.¹⁰

II. MATERIAL AND METHODS

Study design and patient selection

Three systemically healthy female patients aged 22, 24 and 25 years presented with concerns regarding excessive gingival display and the short appearance of their maxillary anterior teeth. The principal aesthetic concern was the disproportion between the visible clinical crown and the amount of gingival tissue displayed during smiling.

A comprehensive periodontal and aesthetic examination was performed for each patient. Medical and dental histories were obtained, followed by assessment of gingival health, gingival phenotype, periodontal

probing, clinical crown dimensions, gingival margin position and tooth morphology. Clinical photographs were obtained before treatment to document the smile and gingival architecture.

The maxillary anterior region from 13 to 23 was selected for treatment in all three cases. Particular attention was given to the symmetry of the gingival margins, tooth width-to-length relationship and the amount of tooth structure that could be predictably exposed without compromising periodontal support.

The treatment plan and anticipated aesthetic changes were explained to the patients, and informed consent for the proposed periodontal surgical treatment was obtained.

Clinical measurements and treatment planning

The treatment planning protocol was based on the principles described for Chu aesthetic gauge-guided crown lengthening. The position of the alveolar crest was first assessed using transgingival probing. Bone sounding is particularly useful in the aesthetic zone because the apparent amount of gingival tissue does not necessarily indicate the actual distance between the gingival margin and alveolar crest.¹⁰

The Chu proportion gauge was then used to assess the existing tooth width-to-length relationship. The incisal stop was positioned against the incisal edge, and the colour-coded bands were used to determine the appropriate clinical crown dimensions. In the Chu system, the colour coding corresponds to different anterior tooth groups, with red associated with central incisors, blue with lateral incisors and yellow with canines. The bands allow adjustment according to individual tooth dimensions, including movement one band upward for larger teeth or one band downward for smaller teeth.¹⁰

Following determination of the desired clinical crown length, the planned gingival margin was transferred clinically using bleeding points. This provided a visual guide for the subsequent gingival excision.

The relationship between the planned gingival margin and the underlying alveolar crest was also considered. The relationship between the planned gingival margin and the underlying alveolar crest was carefully assessed to determine the extent of osseous reduction required. Osseous reduction was planned to establish an adequate distance between the alveolar crest and the final gingival margin, thereby facilitating maintenance and re-establishment of the biologic width while preserving the periodontal support and harmonious gingival architecture.⁴⁻⁶

Surgical procedure

Local anesthesia was administered in the maxillary anterior region. After adequate anesthesia and isolation of the surgical field, the planned gingival margin was identified according to the measurements obtained with the Chu proportion gauge.

An external bevel incision was performed using a No. 15 surgical blade following the predetermined gingival contour. The incision was designed to reproduce a symmetrical and physiologically acceptable gingival architecture while exposing the desired additional clinical crown.

The excised soft tissue was removed carefully, and the surgical field was irrigated with sterile saline.

Following gingival excision, a full-thickness periodontal flap was elevated to allow direct visualization and assessment of the underlying periodontal tissues, osseous reduction is performed thereafter to maintain the biological width.

The exposed root surfaces were carefully debrided to remove residual deposits and facilitate a clean periodontal environment before flap repositioning.

Osseous reduction was subsequently performed in all three patients. The amount of bone reduction was determined according to the desired clinical crown length and the existing position of the alveolar crest, using the Chu biologic periogauge as an intraoperative reference. The objective was to establish an adequate biologic dimension between the alveolar crest and the planned final gingival margin. The osseous recontouring was performed conservatively to obtain a physiologic and harmonious osseous architecture while avoiding unnecessary removal of supporting bone.

The Chu biologic periogauge was used intraoperatively as a reference for establishing the relationship between the desired clinical crown length and the underlying periodontal tissues. The gauge incorporates colour-coded measurements on its arms and allows simultaneous consideration of the clinical crown and biologic crown dimensions.¹⁰ The original Chu protocol describes a preset 3-mm midfacial dentogingival measurement on the periogauge, providing a clinical reference for determining the relationship between the desired clinical crown and alveolar crest.¹⁰

Following flap elevation, the level of the alveolar crest was assessed and the required amount of osseous reduction was determined using the Chu biologic periogauge. Osseous reduction was performed in all three cases to establish an appropriate distance between the alveolar crest and the planned gingival margin, thereby providing adequate space for maintenance of the biologic width. The osseous contour was carefully modified while preserving the physiologic architecture and periodontal support.

After completion of the surgical procedure, the flap was repositioned according to the planned gingival architecture and secured with sutures. The surgical site was irrigated, and postoperative instructions were provided.

Postoperative management

Patients were instructed regarding maintenance of oral hygiene and avoidance of mechanical trauma to the treated area during the initial healing period. Analgesics were prescribed as required for postoperative discomfort.

The patients were reviewed during the early postoperative period to assess wound healing, gingival contour and patient-reported discomfort. Subsequent follow-up examinations were performed to evaluate the stability of the gingival margin and the aesthetic result.

Clinical crown length, transgingival probing measurements and marginal gingival levels were recorded during follow-up. Postoperative discomfort was assessed using the Visual Analogue Scale (VAS), while overall patient satisfaction was recorded based on the patient's perception of the aesthetic outcome.



Figure 1. Clinical sequence of Chu aesthetic gauge-guided aesthetic crown lengthening.

(A) Preoperative intraoral view showing excessive gingival display and short-appearing maxillary anterior clinical crowns. (B–C) Assessment and determination of the desired clinical crown dimensions using the Chu aesthetic gauge. (D) Marking of the planned gingival margin with bleeding points. (E–F) Gingival excision and incision following the predetermined gingival contour. (G–H) Flap elevation and completion of osseous recontouring followed by flap repositioning and suturing.



Figure 2. Preoperative and postoperative clinical photographs of the three cases following aesthetic crown lengthening. Extraoral smile and intraoral photographs demonstrating the clinical presentation before treatment and the postoperative outcome following Chu aesthetic gauge-guided crown lengthening. The photographs demonstrate reduction in excessive gingival display, increased clinical crown exposure, and improvement in the gingival-to-tooth relationship and overall gingival architecture.

Extraoral smile and intraoral photographs demonstrate the clinical presentation before treatment and the postoperative outcome following Chu aesthetic gauge-guided crown lengthening, including reduction in excessive gingival display, increased clinical crown exposure, and improvement in gingival-to-tooth relationship and overall gingival architecture.

III. RESULTS

All three patients demonstrated an increase in the visible clinical crown dimensions following aesthetic crown lengthening.

The mean clinical crown length increased from 6.5 mm at baseline to 8.5 mm immediately after treatment and 9.5 mm during subsequent follow-up. This increase represented a clinically evident improvement in the amount of tooth structure visible during smiling.

The mean transgingival probing measurement decreased from 4.65 mm at baseline to 3.33 mm postoperatively, followed by measurements of 3.0 mm at 1 month and 3.5 mm at 3 months. The changes demonstrated modification of the relationship between the gingival margin and underlying periodontal tissues following surgery.

The mean marginal gingival level changed from 4.5 mm at baseline to 2.5 mm postoperatively, followed by 2.33 mm at 1 month and 3.33 mm at 3 months. A degree of positional change was observed during follow-up, consistent with the remodeling and maturation of periodontal tissues after surgery.

The increase in clinical crown length was achieved through combined soft-tissue resection and osseous reduction performed according to the planned clinical crown dimensions.

Postoperative pain was generally mild. The VAS scores showed an overall reduction during follow-up, indicating progressive improvement in postoperative comfort. Although transient postoperative discomfort was observed, no major surgical complication was documented.

All three patients reported satisfaction with the postoperative aesthetic appearance. The improvement in visible clinical crown length and reduction in excessive gingival display produced a more harmonious relationship between the maxillary anterior teeth and gingival tissues.

Table 1: Clinical and patient-reported outcomes at baseline and follow-up.

Parameter	Baseline	Postoperative	1 week	1 month	3 months
Clinical crown length (mean, mm)	6.5	8.5	—	9.5	9.5
Transgingival probing (mean, mm)	4.65	3.33	—	3.0	3.5
Marginal gingival level (mean, mm)	4.5	2.5	—	2.33	3.33
VAS pain score (mean, 0–10)	—	2.0	3.0	1.0	0.33
Patient satisfaction score (mean, 0–10)	—	7.67	7.83	9.50	10.0

IV. DISCUSSION

Aesthetic crown lengthening is a periodontal procedure in which the final position of the gingival margin is determined not simply by the amount of gingiva that appears excessive, but by the relationship between tooth dimensions, gingival architecture and the underlying periodontal tissues.^{1,2} In the present three cases, the primary aesthetic complaint was excessive gingival display associated with short-appearing maxillary anterior teeth.

An important diagnostic consideration is whether the apparent shortness of the teeth is actually caused by excessive gingival coverage. In patients with altered passive eruption, the gingival margin may remain positioned coronally despite an anatomically normal tooth.³ In such patients, carefully planned resective periodontal surgery may expose a greater portion of the anatomical crown and improve the tooth-to-gingiva relationship.

The present cases demonstrate the potential usefulness of the Chu gauge system in this situation. Conventional aesthetic crown lengthening may depend substantially on visual estimation. However, tooth proportions are three-dimensional and vary between individuals. Chu's biometric approach was developed to provide an objective method for evaluating clinical crown discrepancies and tooth width-to-length relationships.⁷

The Chu proportion gauge is particularly useful during the planning stage. Rather than determining the amount of gingiva to remove solely by visual inspection, the clinician can establish a desired clinical crown length in relation to the existing tooth width. The colour-coded system facilitates rapid intraoral assessment.^{7–9}

The second important component is assessment of the periodontal tissues. The biologic width concept has historically provided a framework for understanding the space occupied by the connective tissue attachment and junctional epithelium.⁴ Vacek et al. demonstrated that the dimensions of the dentogingival junction vary considerably among individuals, supporting the need for individualized assessment rather than assuming an identical measurement for every patient.⁵ Kois also emphasized differences between facial and interproximal dentogingival dimensions.⁶

Osseous reduction is particularly relevant when aesthetic crown lengthening is performed in the anterior region and the existing alveolar crest is located close to the planned gingival margin. In such circumstances, simply removing the coronal soft tissue may result in an inadequate periodontal dimension. The use of the Chu biologic periogauge provides an intraoperative reference for relating the desired clinical crown length to the underlying osseous crest.¹⁰ In the present cases, this principle was applied by performing osseous reduction after flap elevation, thereby allowing direct visualization of the alveolar crest and controlled modification of the osseous level.

This is particularly relevant during aesthetic crown lengthening because excessive tissue removal may produce an undesirable gingival architecture, while inadequate treatment may fail to provide the desired clinical crown exposure. Therefore, assessment of the alveolar crest through transgingival probing is an important component of treatment planning. Bone sounding allows the clinician to estimate the position of the underlying alveolar crest before surgery.¹⁰

The Chu aesthetic gauge system incorporates this concept into a sequential treatment protocol. In the protocol described by Nautiyal et al., bone sounding is performed first, followed by assessment of tooth width-to-length proportions with the Chu proportion gauge. Bleeding points are then established according to the desired clinical crown length, followed by gingivectomy and flap reflection. The biologic periogauge is subsequently used to relate clinical crown dimensions to the underlying periodontal structures.¹⁰

An important feature of this approach is that aesthetic planning precedes surgical tissue removal. This is clinically significant because the amount of gingiva that appears excessive to the patient is not necessarily equivalent to the amount of tissue that should be removed surgically.

In the present cases, the procedure included gingival excision followed by flap elevation and periodontal debridement. This allowed the surgical field to be directly evaluated and permitted management of the periodontal tissues before flap repositioning. The use of a gauge provided an objective reference for the desired crown proportions rather than relying exclusively on visual estimation.

The results demonstrated an increase in clinical crown length from a mean of 6.5 mm to 8.5 mm immediately after surgery and 9.5 mm during follow-up. This change was associated with an improved appearance of the maxillary anterior teeth. Similar improvement in clinical crown exposure following aesthetic crown lengthening has been reported in case-based literature.²

The marginal gingival level demonstrated some positional change during the follow-up period. This observation is clinically important because gingival tissues do not necessarily remain at exactly the same position immediately after periodontal surgery. Healing involves reorganization and maturation of the periodontal tissues, and changes in gingival position may occur during this period. Previous clinical studies have similarly demonstrated changes in gingival margin position following surgical crown lengthening.¹⁰

Nautiyal et al. reported that positional changes in periodontal tissues were largely stabilized by approximately three months, while biologic width changes continued during subsequent healing.¹⁰ Although the present series involved only three cases and a shorter follow-up period, the changes observed in marginal gingival position emphasize the importance of postoperative monitoring before considering the result completely stable.

An important consideration in aesthetic crown lengthening is determining whether soft-tissue excision alone is sufficient or whether osseous reduction is required. Gingivectomy alone may be appropriate when adequate distance exists between the planned gingival margin and alveolar crest.² However, when the alveolar crest is positioned too close to the desired final gingival margin, osseous reduction becomes an important component of treatment to establish adequate periodontal dimensions.¹⁰ In the present three cases, osseous reduction was performed following flap elevation in conjunction with gingival excision. The amount of osseous reduction was determined according to the desired clinical crown dimensions and the existing alveolar crest position, with the Chu biologic periogauge serving as an intraoperative reference. This approach was intended to provide adequate space for maintenance of the biologic width while achieving the planned aesthetic gingival margin.

Patient-reported outcomes are also important in aesthetic periodontal procedures. Unlike purely functional periodontal therapy, aesthetic crown lengthening is elective and the patient's perception of the final smile is an important component of treatment success.² In the present cases, postoperative pain was generally mild and decreased during follow-up. Patient satisfaction was favorable, with the patients reporting satisfaction with the improved appearance.

The use of the Chu gauge may therefore have two principal clinical advantages. First, it provides a biometric reference for tooth proportion, helping the clinician determine how much additional clinical crown should ideally be displayed. Second, it provides a visual intraoperative reference, potentially reducing dependence on subjective estimation. The original clinical work of Chu and colleagues and the subsequent study by Nautiyal et al. support the concept of using these gauges as part of a structured aesthetic crown-lengthening protocol.⁷⁻¹⁰ However, several limitations of the present case series should be acknowledged. The sample consisted of only three patients, and there was no control group. Therefore, the findings cannot establish superiority of the Chu gauge over conventional aesthetic crown-lengthening techniques. The follow-up period was also limited, and long-term stability of the gingival margin cannot be determined from the present observations. In addition, excessive gingival display can have multiple etiologies, including altered passive eruption, vertical maxillary excess, hypermobility or hyperactivity of the upper lip, and other anatomical factors. Crown lengthening alone may therefore not be appropriate for every patient presenting with a gummy smile.²

V. CONCLUSION

Within the limitations of this three-case series, Chu aesthetic gauge-guided aesthetic crown lengthening resulted in increased clinical crown exposure, favorable modification of the gingival margin and satisfactory aesthetic outcomes in patients presenting with excessive gingival display.

The use of the Chu proportion gauge provided a systematic method for determining harmonious clinical crown dimensions, while the Chu biologic periogauge, together with direct assessment of the alveolar crest following flap elevation, assisted in determining the required osseous reduction and final gingival margin position.

The technique may reduce reliance on subjective visual estimation and provide a reproducible framework for aesthetic crown-lengthening treatment planning.

Nevertheless, the findings should be interpreted cautiously because of the small number of cases and limited follow-up. Larger prospective clinical studies with standardized measurements, control groups and long-term evaluation are required to determine the predictability and stability of Chu aesthetic gauge-guided crown lengthening.

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