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Chu-aesthetic gauges: The precision implement for aesthetic crown lengthening and evaluation of biologic width

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***Abstract*---**Chu aesthetic gauges are one of their own kind and unique set of devices that uses adequate crown proportions to determine the exact position of the osseous contour supporting the teeth in concern. The aim of this study was to perform aesthetic crown lengthening using these gauges and evaluate the healing of biologic width. 15 systemically healthy patients participated in this study. Aesthetic crown lengthening was performed in the maxillary anteriors using these gauges. Along with this evaluation of level of biologic width was done at baseline, 3months and 6 months. The literature indicated that even though periodontal tissue remodels after surgery and positional changes are noted but they get stabilized after three months. Besides this, the biologic width re- establishes itself to original vertical levels

by 3 months and it attains a proper state of equilibrium in about 6 months. The authors concluded that it was possible using Chu-aestehtic gauges, to achieve ideal crown length-width ratio. At the same time it yielded a beneficial biologic width level for future restorative or prosthetic purpose. The unique approach by these gauges is an innovative and novel method in modern era.

***Keywords*---**Chu aesthetic gauges, crown lengthening, biologic width, sulcus depth.

Introduction

It is a well-known fact that practitioners tend to underestimate the amount of tooth structure that must be exposed during a crown lengthening procedure, leading to biologic width violation. Various subjective methods have been followed in the past, like the use of acrylic templates but these are imprecise and burden the patient with additional cost and multiple visits.1 Current standards dictate the importance of avoiding procedures that will result in aesthetic compromise as well as the concept of providing patients with improved aesthetics whenever possible. Nevertheless, essential goal of treatment is long-term stability of the result; for this to be achieved the integrity of the dentogingival junction must be respected, and dental restorations and the periodontium must be in harmony. A predictable, successful outcome can only be expected if a complete and accurate diagnosis is obtained and used to generate an appropriate treatment plan.2

In aesthetic dentistry where development of the proper tooth size, form, and color of restorations are critical to clinical success, often the periodontal component is considerable and must be addressed for a predictable aesthetic outcome. The need to establish the correct tooth size and thus individual tooth proportion drives the periodontal component of aesthetic restorative dentistry. One specific area of concern is excessively short teeth, where the lack of tooth display and excessive gingival display require clinical crown lengthening that can present a clinical dilemma for the aesthetic-oriented periodontist.3

Thus an objective measuring device would prove to be a valuable aid in assuring that sufficient tooth structure is exposed, as well as in establishing a clinical crown with ideal width-to-length proportional relationship. Chu aesthetic gauges are one such measuring devices which are a series of innovatively designed, color coded measurement gauges that provide a biologically based, step-by-step approach to periodontal aesthetic crown lengthening.1 It has a “BLPG Tip” designed to measure the midfacial length of the anticipated restored clinical crown and the length of the biologic crown (i.e., bone crest to the incisal edge) simultaneously during surgical crown lengthening.[3] Thus, the aim of the present study is to describe an innovative approach and evaluate the healing of biologic width, to periodontal aesthetic crown lengthening utilizing measurement gauges specifically designed for a predictable surgical outcome, thus setting a new standard of diagnosis and treatment within the aesthetic zone.

Materials & Method

Experimental Section
Study design

This Randomized Controlled Clinical trial study was carried out in the Department of Periodontology, Rungta College of Dental Sciences and Research, affiliated to Pt.Deendayal Upadhyay University of Chhattisgarh, from Jan 2021-June 2021. A total of 15 systemically healthy patients (11 women & 4 men) requiring crown-lengthening in relation to maxillary anterior teeth were enrolled in this study. The motive behind performing crown lengthening surgery in this study was to provide enough tooth structure to facilitate placement of restorative margin (if required) such that it did not violate the biologic width and hence restored not only an aesthetically pleasing smile but also a long lasting restoration. All patients received an initial examination and were informed about the treatment plan. Oral hygiene instructions were given to all the participants along with scaling and oral prophylaxis. Each patient was duly informed about the study & written informed consents were taken before their participation.

Case selection Inclusion criteria

1. Patients who themselves reported to the outpatient department of Periodontology, stating that they were unhappy with their present smiles (due to Gummy Smile or discrepancy in the ratio of tooth length to width or uneven wear of tooth structure or faulty restorations) were taken into the study after taking into account their biologic width requirements
2. Systemically healthy patients between the age group 18- 30 years both males and females
3. Patients who were compliant and were able to maintain good oral hygiene after completion of initial phase of periodontal therapy.
4. Those who required maxillary anterior crown lengthening surgery to correct disproportionate length to width ratios resulting in unaesthetic smiles.
5. Patients who had not received any kind of antimicrobial therapy for past 3 months.
6. Absence of gingival hyperplasia as well as any kind of periodontal disease.

Exclusion criteria

1. Presence of periodontal pockets ≥4mm
2. Local or systemic contraindications to periodontal surgery
3. Patients who had received any kind of periodontal therapy in the past 6 months
4. Pregnant and lactating mothers
5. Smokers
6. Compromised adjacent alveolar bone support
7. Mobile teeth
8. Unfavourable crown to root ratio.

Clinical parameters

All measurements were recorded by a single blinded calibrated examiner using standardized UNC-15 probe (Hu-Friedy) and rounded to the nearest 0.5 mm. Two sets of readings were taken on those 15 patients in a two-hour interval by that single examiner to avoid discrepancy in recording measurements.

- Plaque Index (PI)- (Silness and Loe, 1964)[4]
- Gingival Index (GI)- (Loe and Silness, 1963)[4]
- Clinical Attachment Level (CAL)- Distance from the fixed reference point to the base of the pocket
- Probing Pocket Depth (PPD)- CAL minus Position of Gingival Margin
- Biologic Width (BW)-Bone sounding minus sulcus depth

All clinical parameters were recorded and the area of interest was anesthetized followed by Bone Sounding (BS) to obtain bone level (BL) via transgingival probing.

The selected sites were divided into three groups:

1. Treated (TS) sites: Sites on teeth selected for crown- lengthening;
2. Adjacent (AS) sites: Interproximal sites that shared a proximal surface with the treated tooth; (3) Nonadjacent (NAS) sites: Interproximal sites away from the treated tooth.

All clinical parameters were recorded at six sites (mesiobuccal, midbuccal, distobuccal and mesiopalatal, mid palatal and distopalatal) around every TS, AS and NAS site at baseline, 3 and 6 months.

Case description

After completion of oral prophylaxis and assessing good patient compliance, patients were prepared for surgical phase. Pre operative photographs (Fig.1) of the patients were taken. At baseline, sulcus depth (Fig.2) and bone sounding (Fig.3) were recorded prior to the surgical procedure.

Fig 1 Preoperative photograph

Fig 2 Pre-operative sulcus depth at baseline

Fig 3 Bone sounding at baseline

The area of interest, which was maxillary anterior teeth from right canine to left canine, was anaesthetized with 2% lignocaine HCL containing 1:80,000 adrenaline solution. The biological width was identified by probing to the bone level, referred to as sounding to bone, and subtracting the sulcus depth from the resulting measurement, via transgingival probing. Chu proportion gauge was used to determine the length is to width ratio of the crowns (Fig.4).

Fig 4 Pre-operative clinical crown length measured using Chu-aesthetic gauge

On the incisal edge of the tooth, the incisal stop of the Chu proportion gauge was placed. On the horizontal arm, each color coded band corresponded to the same colour coded band as on the vertical arm. The red band stands for the length and width of the central incisors, yellow for canines and blue for lateral incisors. Depending on individual tooth size variations, it is moved either one band up (for

larger teeth) or one band down (for smaller teeth). A diagnosis of crown length to width discrepancy is concluded, if the colour coded bands do not coincide with existing tooth proportions. Next, the bleeding points were marked using the Chu-proportion gauge (Fig.5a,5b). To achieve the ideal anatomic crown length and appropriate crown width, internal bevel gingivectomy was performed (Fig.6). A full thickness flap was reflected and debridement was done.

Fig 5-a Chu-Aesthetic gauge being used as a guide to mark the bleeding points before performing the procedure.

Fig 05-b Bleeding points marked

Fig 6 Incision line showing Internal bevel Gingivectomy being performed Chu biologic periogauge was used to achieve the proper midfacial clinical and biologic crown length simultaneously as it had a preset midfacial dentogingival measurement of 3 mm. The clinical crown length was determined using the color code on shorter arm and those on longer arm represented biologic crown length. Thus, facilitating in determining the exact amount of bone to be resected. Next, ostectomy was performed. Immediately after ostectomy, the biologic width level was measured using Chu-Aesthetic Gauges (Fig 7a, 7b). The flaps were then approximated with sutures and Coe-pack was placed as periodontal dressing on the operated site.

Fig 7 a After ostectomy, measuring the level of biologic width at midfacial aspect

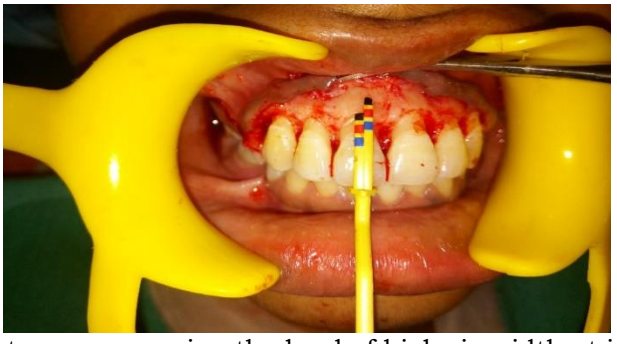


Fig 7 b After ostectomy, measuring the level of biologic width at interdental aspect

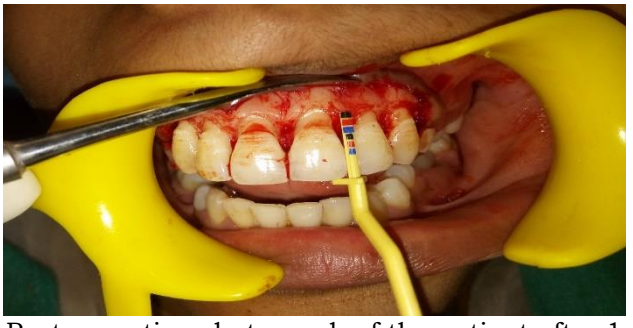


Fig 8 Post operative photograph of the patient after 1 week

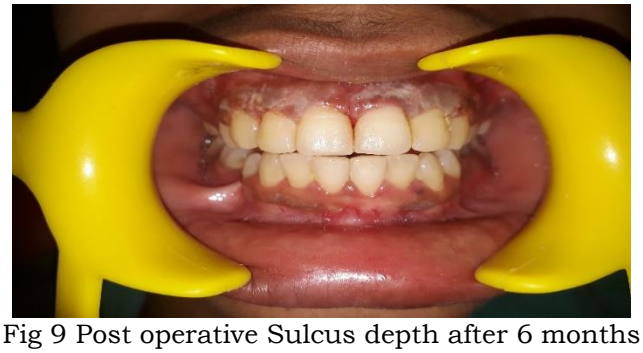


Fig 9 Post operative Sulcus depth after 6 months

Postoperative Instructions

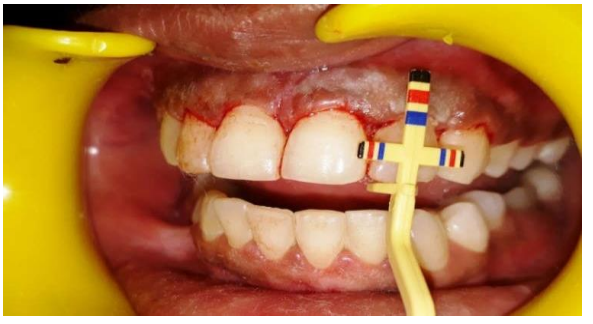
Postoperative instructions included the intermittent use of ice packs on the operated side on the face for the first 24 hours, not chewing from the treated side, eating semisolid foods, rinsing with warm saline solution two to three times a day after the day of surgery, avoiding excessive exertion of any type, not brushing for the first week, and not flossing for 3 weeks. 0.12% chlorhexidine mouthwash was prescribed along with systemic antibiotics and analgesics for patient's comfort.

Post-Surgical Visits

Patients were recalled 1 week after surgery for suture removal and overall oral hygiene reinforcement (Fig.8). All subjects were recalled at 3 and 6 months postoperatively. At these visits, all clinical parameters were re-recorded, which included sulcus depth (Fig.9), bone sounding (Fig.10) and post operative clinical crwon length using the gauge (Fig.11).

Fig 10 Post operative Bone sounding after 6 months

Fig 11 Post operative clinical crown length measured using Chu-aesthetic gauge after 6 months



The permanent restoration of crowns, if required in case of faulty restorations or uneven wear of tooth structure, were done after six months of uneventful healing.
Statistical analysis: Data obtained for each type of site per patient was assessed for differences between baseline to 3 months and 6 months. Data were analyzed using paired t-test since all the data was quantitative in nature. All data was determined to asess the overall reduction in clinical parameters. The analysis

were performed using IBM-SPSS 16.0 software version for windows. A p-value of less than 0.05 was considered to be statistically significant.

Results

All 15 patients were compliant and completed the study along with follow up. Neither any post surgical complication was reported nor any prosthetic complication was seen.

Plaque Index (PI) & Gingival Index (GI)

The mean values of PI & GI ranged from 1.89 and 1.83 to 1.51 and 1.43 from baseline to six months respectively. No statistically significant difference was observed in relation to PI & GI at the treated, adjacent and non adjacent sites at any interval of time. (Table 1)

Biologic Width Changes

The mean biologic width of all the treated, adjacent and non adjacent sites increased from 3.34 to 4.36 from baseline to 3 months and further from 4.36 to 4.82 from 3 months to 6 months. The results thus obtained were statistically significant from baseline to 3 months , however the differences obtained between 3 months to 6 months were statistically non significant. (Table 1)

Table 1 Statistical Summary for PI,GI and Biologic Width Mean Values at baseline, 3 months & 6 months

Parameters	Baseline (Mean±SD)	P Value	3 Months(Mean±SD)	P Value	6 Months (Mean ±SD)	P Value
Plaque Index	1.89±0.28	0.25	1.53±0.21	0.26	1.51±0.22	0.96
Gingival Index	1.83±0.31	0.67	1.46±0.25	0.87	1.43±0.23	0.34
Biologic Width	3.34±0.63	0.015	4.36±0.76	0.02	4.82±0.76	0.06

p> 0.05= Non Significant; p< 0.05 Significant; p< 0.02 Highly Significant

Probing Pocket Depth(PPD) and Clinical Attachment Level (CAL)

The results procured by statistical analysis for PPD & CAL levels after 6 months were significantly in favor for both. The mean difference for PPD ranged from 3.83 to 1.34 from baseline to 6 months respectively, which was statistically significant. The mean observations for CAL differed from 5.77 to 3.54 from baseline to 6 months respectively, which was again statistically significant. (Table 2)

(Table 2) Statistical Summary for PPD and CAL Mean values at Baseline, 3months and 6 months

Parameters	Baseline (Mean±SD)	P Value	3 Months(Mean±SD	P Value	6 Months (Mean ±SD)	P Value
Probing Pocket Depth	3.83±0.92	0.03	1.39±1.51	0.015	1.34±1.51	0.015
Clinical Attachment Level	5.77±0.90	0.03	3.69±091	0.02	3.54±0.92	0.02

p> 0.05= Non Significant; p< 0.05 Significant; p< 0.02 Highly Significan

Discussion

The health of periodontal tissue is dependent on properly designed restoration. Incorrectly placed restorative margins and poorly adapted restorations violate the biologic width. The biological width is defined as the dimension of the soft tissue, which is attached to the portion of the tooth coronal to the crest of the alveolar bone5. The term “Biologic width” was based on the work of Gargiulo et al6, who described the dimensions and relationship of the dentogingival junction in humans. They examined 287 individual teeth from 30 autopsy specimens and made the measurements from those dentogingival components of teeth and entrenched the fact that there is a definite proportional relationship between the alveolar crest, the connective tissue attachment, the epithelial attachment and the sulcus depth. They delineated the following mean dimensions: A sulcus depth of 0.69 mm, an epithelial attachment of 0.97 mm, and a connective tissue attachment of 1.07 mm. Based on this work, the biologic width is commonly stated to be 2.04 mm, which represents the sum of the epithelial and connective tissue measurements.

The pinnacle of this study is attributed to the increase in the biologic width dimension from baseline to three months and from baseline to six months. However, this aspect was noted only in the treated and the adjacent site and statistically also difference was seen in the above mentioned sites. This further attributes to the fact that periodontal tissue remodels after surgery. The changes in the treated and adjacent sites can be ascribed to the osseous reduction. Achieving the positive architecture of the alveolar bone was of prime importance, which yielded to the significant results seen in the treated and adjacent sites. This theory is aided by a study done by Wilderman et al.7, who stated that the remodeling of alveolar bone can continue over a year as seen histologically. The results they obtained at the end of six months showed the biologic width reestablishment to a more apical region than its previous vertical dimension. This fact could be supported by analyzing the slight gain in the attachment level and apical displacement of the bone level.

The above findings are similar to a study leaded by Shobha et al.8, on clinical evaluation of crown lengthening procedure, where at the end of six months the conclusion drawn was the re-establishment of the biologic width to its original

vertical dimension along with an overall gain of 2mm length of coronal tooth structure. However, in contrast to the findings of our results, Lanning et al.9 reported no significant difference in the apical positioning of free gingival margins at the treated sites with the adjacent and non-treated sites. Also at the end of 6 months, the biologic width at all sites was comparatively smaller than expected. The authors of the former study clearly imputed their findings to the surgical technique carried out by them, in which the amount of bone resection was arbitrarily done pursuing Smukler H et al.10, who based the osseous resection on the intended prosthetic margin and the original length of the biologic width.

Nevertheless, there are debates as seen in the literature, regarding the ideal time for restoration of tooth undergone crown lengthening surgery. Some say that the restorative procedures must be delayed until new gingival crevice develops after periodontal surgery11. In non esthetic areas, the site should be re-evaluated atleast 6 weeks post surgically, prior to final restorative procedures, where as in esthetic areas, healing period of a longer duration is recommended to prevent apical migration of the gingiva. Wise12 suggests 21 weeks time for the stability of soft tissue gingival margin. Therefore, restorative treatment should only be initiated after 4-6 months. Furthermore, the margin of the provisional restoration should not hinder healing before the biologic width is established by surgical procedures8.

The results of our present study also support the views of Pontoriero et al.13, Fletcher et al.14, Shobha et al.8, Herrero et al.15, and Bragger et al.16, that although the positional changes of the gingival margin, probing depth and attachment levels are stabilized by 3 months, it takes a minimum of six months for the biologic width to re-establish itself. One of the major aspects that had positive influence on our results was that, the bone sounding which was carried out, was accurately measured after flap reflection and was taken as a closed measurement. However, short sample size being one of the limitations of our study, further long term clinical trials in future are required to validate the efficacy of this distinctive scale and evaluate the healing of biologic width.

Conclusion

The foremost focus of this study was to perform surgical crown lengthening for aesthetic puropose using Chu aesthetic gauges and to evaluate the healing of biologic width over a followup period of six months. We conclude the findings that there is stabilization in the positional changes of the periodontal tissues and the biologic width within three months. The biologic width re-establishes itself to its original vertical levels and gets stabilized within a time period of six months. Within limitations of our study, the positive co-relations with respect to clinical relevance was due to our the gradual approach to periodontal aesthetic crown lengthening, with the help of an innovative aesthetic measuring gauge, the Chu aesthetic gauge. These unique set of measuring devices not only determines the ideal clinical length of an anterior tooth but also provides a guide as to how precisely the amount of bone has to be resected. The main idea behind these impressive set of devices is to rule out visual precision and establish a definite and predictable method for diagnosis and treatment planning for future well informed and highly aesthetic-concerned patients.

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