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## **A Clinical Evaluation Of Chu's Esthetic Gauges In Crown Lengthening Procedures In The Maxillary Anterior Region-A Randomised Study**

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### **ABSTRACT**

Crown Lengthening is a surgical procedure performed to increase the tooth support for a fixed prosthesis or for a better aesthetic outcome while preserving the biologic width around a tooth. Chu's Esthetic Gauges help the clinician to visualize the surgical procedure better with the help of certain specific markings. Thus, maintaining the golden proportion of the teeth leads to a superior outcome. To clinically evaluate the positional changes of the gingiva, alveolar bone, and biologic width following surgical crown lengthening procedure using Chu's esthetic gauges to that of the pre-surgical measurements in the Indian population. A randomized study was carried out at 30 maxillary anterior sites requiring a crown lengthening procedure. Baseline data was recorded and surgery was performed using Chu's Esthetic Gauges. The data was again recorded after 3 months. Chi-square analysis was used to find the significance of study parameters on a categorical scale. Student t-tests (two-tailed, paired) were used to find the significance of study parameters on the continuous scale within the group at different time intervals. On evaluation, the differences in the mean gingival index were statistically insignificant. The position of the gingival margin and Relative attachment level-shifted apically but the sulcus depth was maintained. The change in probing depth, Biologic width, and biologic width in a thick and thin biotype of gingiva was statistically non-significant. A total of 83.33% of treated sites had complete papilla fill, resulting in better esthetics. The Chu's Esthetic Gauges helped in determining the ideal Golden

Proportion of a tooth and on the basis of this measurement, determine the position of the alveolar crest to maintain the biologic width. It enables the operator to identify the anatomic crown and clinical crown.

**Keywords:** Esthetics, Chu'S, golden proportion.

## **INTRODUCTION**

One of the most common periodontal surgeries carried out for esthetic and functional correction is crown lengthening. Some indications for crown-lengthening surgery include Excess gingival display due to a delay in passive eruption resulting in the appearance of short clinical crowns, exposure of subgingival caries or fractures, and maintaining the biologic width during prosthetic restorations. If the patient desires an anterior dentition that is more normal in tooth length, respective treatment that exposes the anatomical crowns may be warranted.<sup>1, 2, 3</sup>When performing a crown lengthening procedure in the maxillary anterior region, it is of utmost importance that the esthetic results are optimized for better outcomes and patient acceptance. Traditionally, dental instruments such as periodontal probes, prefabricated templates/stents have been used as clinical indicators of diseases such as periodontitis, with their numerical values indicative of health or stages of the disease.<sup>4</sup> More recently, instruments like Chu's Aesthetic Gauges, (Hu-Friedy Inc., Chicago, IL) have been created to diagnose and predictably treat aesthetic tooth discrepancies and deformities without violating the biologic width.<sup>6</sup> These instruments help to analyse the dimensions of the tooth numerically and thus eliminate the subjective approximations by direct visual assessment of aesthetic tooth proportions. Once proper tooth size and proportion are established, the appropriate adjunctive periodontal procedure can be determined (i.e., Mesio-Facial and Inter-Dental clinical crown lengthening).<sup>5,6</sup> Hence, the aim of this study was to clinically evaluate the positional changes of periodontal tissues and biologic width following surgical crown lengthening procedure using Chu's esthetic gauges to that of the pre-surgical measurements in Indian population.

## **MATERIALS AND METHODS**

The subject population consisted of 15 systemically healthy patients (Age: 18-45 years) with 30 sites in maxillary anterior region that required crown lengthening due to esthetic or functional reasons. The participants were selected on a consecutive basis, among patients reporting to D.Y.Patil School of Dentistry, Navi Mumbai. All patients with adjacent missing teeth, periodontally compromised teeth and where crown: root ratio could not be maintained post-surgery were excluded from the study. The patients were given both oral and written detailed information regarding the study, and a written informed consent was obtained from them. The research protocol was

approved by the Institutional Research and Ethical Board, D.Y.Patil University, School of Dentistry, Navi Mumbai.

### **Pre-Surgical Procedures**

A thorough Phase 1 therapy was performed 4 weeks prior to the Crown lengthening procedure. Explanation of oral hygiene instructions and its importance for the success of the surgery was explained to each patient.

Study models were prepared for all the patients and wax-up for each tooth to be treated was done. Custom-made acrylic stents were fabricated on the waxed-up teeth to be treated to serve as a reference point and ensure reproducibility of the subsequent measurement during the surgery and final prosthesis.

Baseline data (Gingival index, Position of the gingival margin, Probing depth, Relative attachment level, Biologic width, Biotype of gingiva, Final papillary placement, and Pinkesthetic score) was collected immediately before the surgical procedure.

### **Surgical Phase**

Chu's aesthetic gauges (Hu-Friedy Inc, Chicago, IL) were used to perform crown lengthening procedures. The surgical area was anesthetized with 2% lignocaine HCL(1:80,000 adrenaline solution). Bone sounding was performed with the help of both UNC-15 probe and Chu's Bone sounding Gauge and the biologic width was determined. The Chu's Proportion gauge was used to determine the tooth width to length ratio by placing the incisal stop of the Chu proportion gauge on the incisal edge of the tooth or the pre-surgical stent prepared. Each colored band on the horizontal arm harmonizes with the same colored band on the vertical arm. The red band stood for the length and width of the central incisors, yellow for canines, and blue for lateral incisors. Depending on variations in tooth size proportions, measurements were moved from one colour to the other. The bleeding points were established, as guided by the Chu-proportion gauge. After the necessary measurements an External bevel gingivectomy (for sites that had adequate attached gingiva) or a Sulcular incision (for sites that had inadequate attached gingiva) was performed with a #15 blade to achieve the ideal anatomic crown length. A full-thickness flap was reflected (Envelope flap where attached gingiva was adequate and apically displaced flap where attached gingiva was inadequate), and the BLPG tip was used to achieve the proper midfacial clinical and biologic crown length simultaneously. The clinical crown length was determined by markings on the shorter arm while the biologic crown length was determined by the markings on the long arm, hence facilitating in determining the exact amount of bone to be respected. The final position of the papilla was determined with the help of Papilla tip. The flaps were then approximated with interrupted sutures.

## **POSTOPERATIVE CARE**

Patients were recalled on the 10<sup>th</sup> day for suture removal. The patients were then recalled after 3 months for-evaluation. In case of any signs of infection or discomfort, the patients were asked to report to the department immediately.

## **Statistical Analysis**

Chi square analysis was used to find the significance of study parameters on categorical scale. Student t tests (two tailed, paired) was used to find the significance of study parameters on continuous scale within the group at different time intervals.

## **RESULTS**

### **Gingival Index (GI)**

The mean of the gingival index at baseline and after 3 months for all the sites was 0.28 and 0.26 respectively. The mean gingival index varied from  $0.28 \pm 0.21$  to  $0.26 \pm 0.21$  with a t value of 1.576 (p value = 0.126) from baseline to 3 months which was statistically insignificant.(Table 1)

### **Gingival Margin (GM)**

The mean of gingival margin at baseline and after 3 months for all the sites was 8.07 and 9.53 respectively. The mean gingival margin varied from  $8.07 \pm 0.94$  to  $9.53 \pm 0.97$  with a tvalue of 11.789 (p value < 0.001) from baseline to 1 month which was statistically highly significant.(Table 1)

### **Probing Depth (PB)**

The mean of probing depth at baseline and after 3 months for all the sites was 1.73 and 1.90 respectively. The mean probing depth varied from  $1.73 \pm 0.74$  to  $1.90 \pm 0.75$  with a t value of 1.409 (p value = 0.169) from baseline to 1 month which was statistically insignificant. (Table 1)

### **Relative Attachment Level (RAL)**

The mean of relative attachment level measured from the incisal edge at baseline and after 3 months for all the sites was 9.80 and 11.43 respectively. The mean relative attachment level varied from  $9.80 \pm 1.27$  to  $11.43 \pm 1.33$  with a t value of 8.391 (p value <0.001) from baseline to 1 month which was statistically Highly significant. (Table 1)

### **Biologic Width (BW)**

The mean of biologic width at baseline and after 3 months for all the sites was 1.87 and 2.07 respectively. The mean biologic width varied from  $1.87 \pm 0.68$  to  $2.07 \pm 0.36$  with a t value of 1.649 (p value = 0.110) from baseline to 1 month which was statistically insignificant. (Table 1)

### **Gingival Biotype (GB)**

The mean of gingival biotype at baseline and after 3 months for all the sites was 1.83 and 1.77 respectively. The mean gingival biotype varied from  $1.83 \pm 0.69$  to  $1.77 \pm 0.62$

with a t value of 1.439 (p value = 0.161) from baseline to 3 month which was statistically insignificant. (Table 1)

#### Complete Papilla Fill (CPF)

The frequency of complete papilla fill at 3 months for all the sites was 25 and for incomplete papilla fill was 5. The percentage of complete papilla fill was 83.33% and percentage of incomplete papilla fill was 16.60 %.( Table 2)

#### Pink Esthetic Score (PES)

The mean of pink esthetic score at baseline and after 3 months for all the sites was 5.87 and 8.00 respectively. The mean pink esthetic score varied from  $5.87 \pm 0.81$  to  $8.00 \pm 0.98$  with a t value of 10.877 (p value < 0.001) from baseline to 1 month which was statistically Highly significant.(Table 1)

#### Biologic Width in different types of Gingival Biotypes (BW-GB)

The mean of biologic width at baseline and after 3 months for thin gingival biotype was 1.70 and 1.90 respectively and for thick gingival biotype 1.95 and 2.15 respectively. (Table 1)

The mean biologic width in thin gingival biotype varied from  $1.70 \pm 0.823$  to  $1.90 \pm 0.316$  with a t value of 0.823 (p value= 0.443) from baseline to 1 month which was statistically insignificant.(Table 1)

The mean biologic width in thick gingival biotype varied from  $1.95 \pm 0.605$  to  $2.15 \pm 0.366$  with a t value of 1.453 (p value = 0.163) from baseline to 1 month which was statistically insignificant.(Table 1)

## DISCUSSION

For the long-term success of a restored tooth, preservation of healthy periodontium is of utmost importance. There is still confusion regarding the term biological width among most clinicians, related to its meaning and relevance to clinical procedures. The concept of biological width comes from a histological description of the dentogingival complex by Gargiulo et al.<sup>7</sup> It is well-known that practitioners tend to underestimate the amount of tooth structure that must be exposed during a crown lengthening procedure, leading to biologic width violation.<sup>8</sup>

The primary objective of the crown-lengthening procedure is the creation of adequate space for the proper placement of prosthetic margins and restoration of adequate biological width. This can be achieved surgically, orthodontically, or by a combination of both. Most authors agree that a minimum distance of 3mm is required from the osseous crest to the final restorative margin following a crown-lengthening procedure to allow the margin to be placed equigingival/supragingival. Thus, 3mm allows for 1mm of supracrestal connective tissue attachment, 1 mm of junctional epithelium, and 1mm for sulcus depth.

However; Libman & Nicholls suggested a 5mm distance from bone to restorative margin. They clarified that the length of the clinical crown, furcations, and esthetic

considerations limit surgery. It was felt that 5mm would allow for individual variations in the biologic width dimensions and would prevent the clinician from removing too little bone.<sup>9</sup>

Clark et al reported that the measurements using an occlusal acrylic stent appear to be better than the measurements made using cemento-enamel junction as a reference point. Although custom-made stents give only the relative attachment level, they ensure consistency of location, inclination, and angulations of a periodontal probe.<sup>10</sup>

In the present study the change in mean gingival index varied from baseline to 3 months which was statistically insignificant. In a similar study done by Lanning et al it was found that no significant changes were noted in the gingival index at the treated sites. This can be attributed to maintenance of proper plaque control as instructed to the patient.<sup>11</sup>

At the treated site; the mean relative gingival margin distance increased during the duration of the study which was statistically highly significant. A similar finding has been reported in the study by Lanning et al who evaluated the biologic width post-surgical crown lengthening and found that there was a greater percentage of the apical shift in free gingival margin position at treated sites from baseline when compared with adjacent sites at 6 months. He concluded that it can be due to the surgical technique used.<sup>11</sup> Also in a study done by Shobha et al to clinically evaluate the biologic width following surgical crown lengthening, it was found that at all sites, there was an apical displacement of the free gingival margin from baseline to 3 months and 6 months.<sup>12</sup> However; the location of the free gingival margin at treated sites was found to be more apically when compared to non-treated sites, which was similar to the observation of our study.

The findings of our study are contrary to the study done by Pontoriero et al who concluded that following surgical crown lengthening, during a 1-year healing period, the marginal periodontal tissues showed a tendency to grow in the coronal direction from the level defined at surgery.<sup>13</sup>

The findings of our study are similar to a study done by Nautiyal et al who evaluated Chu's Esthetic Gauges and concluded that following surgical crown lengthening there was a significant apical displacement in the position of gingival margin at three and six months when compared from baseline in the treated and adjacent sites. Also, there was a greater percentage of apical shift in the free gingival margin position at the treated sites from baseline when compared with non-treated sites at six months.<sup>14</sup>

At the treated site, the baseline probing depth increased from  $1.73 \pm 0.74$  to  $1.90 \pm 0.75$  with a t value of 1.409 (p value = 0.169) at 3 months. The difference in the probing depth from baseline to 3 months was statistically insignificant.

Similar findings were observed by Lanning et al wherein, there was no statistically significant difference in the mean probing depth of the test and control sites at any interval.<sup>11</sup> Contrary finding was also observed in a study conducted by Shobha et al where at the treated sites, there was a statistically significant reduction in probing

depth at 6 months when compared to baseline. This may be because of greater apical shift in the free gingival margin at treated sites.<sup>12</sup> Also in a study conducted by Pontoriero and Carnevale it was concluded that the mean probing depth of buccal and lingual sites or that in the interproximal area were not statistically significant from baseline to 1 year which is similar to our study.<sup>13</sup>

At the treated sites the relative attachment levels increased from  $9.80 \pm 1.27$  to  $11.43 \pm 1.33$  with a t value of 8.391 (p value < 0.001) at baseline to 3 months and results were statistically highly significant.

The results are similar to the finding observed by Lanning et al who concluded that there was an apical shift in the base of the sulcus at all sites and therefore an increase in attachment loss. But there were no significant changes in the attachment levels from 3 to 6 months.<sup>11</sup>

The findings of our study are similar to a study done by Nautiyaletalwho found a significant apical shift in the base of sulcus from baseline to 3 months. They also reported that there was no significant change in attachment levels at all sites from 3 to 6 months.

At treated sites, the biologic width increased and the difference was statistically insignificant.<sup>14</sup>

In a study by Shobhaet al there was no difference in the biological width at all sites at 6 months compared to that at baseline, which was statistically not significant.<sup>12</sup>

Lanning et al demonstrated that the change in biologic width at treated sites was insignificant. They also noted that Biologic width decreased from baseline to 3 months and attained the baseline value at 6 months.<sup>11</sup>The findings are contrary to the findings in the present study. This can be attributed to the short study duration.

In the present study, the change in gingival biotype was statistically insignificant. In the present study, a complete papilla fill was seen in 83.33% of treated sites. Complete papilla fill is important for anterior esthetic procedures as it will result in a more appealing outcome for the patient.

In a case report and literature review by Lanza et al the validity of Pink Esthetic Score index for natural tooth-prosthetic rehabilitation of the anterior area was validated.<sup>15</sup>

In the current study, the Pink Esthetic score increased which was statistically highly significant.

## **CONCLUSION**

The present study observed that the use of Chu's Esthetic Gauges for crown lengthening procedure has provided the operator with additional clinical benefits such as proper visualization of the biologic width while performing the procedure, determining the final placement of the interdental papilla, and accordingly reducing the crest of the bone interdentally to maintain the biologic width at the same time and maintaining the Golden proportion in the prosthesis which would lead to superior esthetic outcomes

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## TABLES

**TABLE 1**

Parameters	Baseline			After 3 months			T value	P value	
	N	Mean	Std. Deviation	N	Mean	Std. Deviation			
Gingival Index	30	0.2830	0.21202	30	0.2657	0.21535	1.576	0.126	
Gingival Margin	30	8.07	0.944	30	9.53	0.973	11.789	<0.001**	
Probing Depth	30	1.73	0.740	30	1.90	0.759	1.409	0.169	
Relative attachment levels	30	9.80	1.270	30	11.43	1.331	8.391	<0.001**	
Biologic Width	30	1.87	0.681	30	2.07	0.365	1.649	0.110	
Gingival Biotype	30	1.83	0.699	30	1.77	0.626	1.439	0.161	
Pink Esthetic Score	30	5.87	0.819	30	8.00	0.983	10.877	<0.001**	
Biologic width in different types of Biotype	Thin	10	1.70	0.823	10	1.90	0.316	0.802	0.443
	Thick	20	1.95	0.605	20	2.15	0.366	1.453	0.163

(p < 0.05 - Significant\*, p < 0.001 - Highly significant\*\*)

**Table 2. Complete papilla fill at 3 months**

Papilla fill	Frequency	Percent
No	5	16.60
Yes	25	83.33
Total	30	100.0

## **Figure legends**

Figure 1- Pre-Operative

Figure 2- Pre Operative Temporaries mimicking the Final Prosthesis in Dimensions

Figure 3(a-d) - Pre-operative measurement of Biologic Width using UNC-15 Probe

Figure 4(a-d) - Pre-operative measurement of Biologic Width using Bone Sounding Gauge

Figure 5(a-d) - Pre-operative assessment of clinical crown length using Proportion Gauge

Figure 6- Post-operative after Incisions

Figure 7(a-d)- Measuring the Biologic width using BLPG Tip before osseous Contouring

Figure 8(a-d) - Measuring the Biologic width using BLPG Tip after osseous Contouring

Figure 9- Immediate Post-Operative

Figure 10- Immediate Post-operative with Temporaries mimicking Final prosthesis in dimensions

Figure 11- Post-operative after 3months

Figure 12- Final prosthesis