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Evaluation of biologic width re-establishment using CHU aesthetic gauges in crown lengthening cases- a clinical study

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ABSTRACT

Background: Present study was performed to assess the biologic width relocation by performing aesthetic crown lengthening with the help of Chu aesthetic gauges.
Methods: The study included 192 teeth from 17 individuals, of which 64 teeth underwent crown lengthening (Treated site- TS) and 128 of which shared a proximal surface (Adjacent site –AS, Non-Adjacent site- NAS) with the surgery site. The clinical parameters Plaque index (PI), gingival index (GI), gingival margin position (PGM), relative attachment level (RAL), bone sounding (BS), biological width (BW), and probing depth (PD) were recorded. The clinical recordings were made at three different times: at baseline, 3 and 6 months post-operatively. Statistical analysis was performed using one way ANOVA and for pair wise comparisons post hoc Tukey test was used. Data was expressed in mean and standard deviations. $P < 0.05$ was considered statistically significant.
Results: PI and GI showed significant difference ($p = 0.000$*) at all time intervals. PGM and RAL were significant from baseline to 3 months, baseline to 6 months ($p = 0.000$*) while non-significance ($p > 0.05$) was recorded at 3–6 months comparison for PGM, RAL, BS, BW and PD.
Conclusion: Present study concluded that usage of Chu Aesthetic gauges help in controlled removal of soft and hard tissues, biologic width and gingival margin position got stabilized within 3 months and final prosthesis can be advised after 3 months of surgery.

1. Introduction

Perio-restorative interdisciplinary approach is a collaborative work between a periodontist and a prosthodontist. So, it is very challenging and tricky task to perform. Thus a thorough knowledge is required to strategically plan a good treatment method for individual patient.[1] When there is insufficient availability of sound tooth structure, to place a crown margin with proper retention and resistance form, periodontal crown lengthening was performed (PCL).

PCL is a surgical procedure used to reduce excess gingival tissue by soft and hard tissue excision (with or without bone re-contouring) in order increase the length of the clinical crown. Maintaining biologic width (BW) allows for long-term restorative survival benefits.[2] Principles of BW were extensively researched and proper protocols were established for perio-restorative relations.[3] Most often PCL is performed as a result of widespread caries, fracture of crown, pre-existing defective margins or failed restorations.[4] Additionally, As an adjunct to cosmetic restoration operations, it is also used to rectify various gingival asymmetries, excessive gingival display, and reposition the dento-gingival complex.[5]

Consequently, this PCL procedure increases the clinical crown length and involve in concurrent increase of biological crown length which is

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measured from the incisal edge of the tooth to the bone crest.[6] Periodontal probes have traditionally been employed as a clinical indicator to diagnose disorders like periodontitis, with numerical values and/or bleeding on probing as indicators of health or disease (i.e. absent or present).[7] During a PCL surgery, they are also used to measure dimensions of the hard and soft tissue. More objective numerical analysis should be used to evaluate and treat aesthetic and anatomic tooth dimensions. Studies done by Nautiyal A et al.,[6] Chu S[8] and Planciunas L et al.,[9] stated that traditional instrument and technique for PCL under-estimate the amount of soft and hard tissue to be removed.

Due to the lack of standardization for the amount of soft and hard tissue removal using conventional PCL procedure, whenever surgical wound heals and when the prosthesis or restoration is placed, the biological width is broken and an endless cycle of pain and inflammation begins. Thus, Chu Aesthetic Probe is designed to eliminate the subjective approximation that comes with a direct visual assessment of the aesthetic proportions of a tooth. Following the establishment of proper tooth size and proportion, the appropriate adjunctive periodontal procedure (i.e., Midfacial and interdental clinical crown lengthening) can be performed.[8,9] Due to limited number of data regarding the above procedure, present study aimed to evaluate the BW healing using Chu-aesthetic gauges in cases of PCL.

2. Study design, sample selection

The current investigation was a single blinded prospective clinical trial. When power of study set as 80% with 95% confidence interval and effect size of 0.098 a sample of 17 was sufficient for conduction of study. A total of 17 systemically healthy individuals (10 men and 7 women, average age 29.4 years) needed crown lengthening in maxillary anterior teeth, were treated in Department of Periodontics, Institute of Dental Sciences, Bareilly. These patients were referred from various departments like Departments of Conservative Dentistry, Orthodontics and Prosthodontics. Apart from this, patients who visited out-patient department of periodontics were also included and treated. Study was performed during October 2016–August 2018 and was planned according to Helsinki Declaration 1975 modified in 2008. Patients were explained thoroughly regarding the clinical protocol, pros and cons of treatment in their vernacular language. Ethical clearance from institutional review board (IDS/ETHCC/16/08) and written informed consent were obtained prior to surgical procedure.

3. Inclusion and exclusion criteria

Inclusion Criteria: Patients within age range between 18 and 50 years, patients having delayed passive eruption, requiring subgingival restorations, if teeth don't have adequate sound structure which may result in lack of retention for crown placement, subgingival caries which are to be restored, for subgingival crown margins or root fracture which are to be exposed and treated, patients having root perforations below gingiva which are to be repaired, patients having a gummy smile, patients having gingival margins discrepancies, and short clinical crowns with high lip (smile) line were included in the study.

Exclusion Criteria: Patients with mobile teeth, periodontal pockets of less than 4 mm, an un-favorable crown-to-root ratio, systemic contraindications to surgery, patients who are under medications that would alter the healing and negatively affect the bone were excluded. Further patients with compromised bone support were also excluded from the study.

4. Site selection

There were 192 teeth in total, 64 teeth of which needed CL and 128 teeth shared a proximal surface with the operative site. Three categories were created from the sites that were chosen: Sites that have been treated (TS) are those on teeth that have been chosen for crown – lengthening, etc. Interproximal sites that share a proximal surface with the treated tooth are referred to as adjacent (AS) sites. Nonadjacent (NAS) sites are those that are interproximal to the treated site.

5. Clinical parameters

Plaque Index (PI),[10] Gingival Index (GI),[11] Position of gingival margin (PGM) (measured from fixed reference point (FRP) and free gingival margin), Relative attachment level (RAL) (measured from FRP to base of pocket), Probing Depth (PD) (RAL- PGM), Bone sounding (BS) (done by *trans*-gingival probing after infiltration of local anesthesia), Biologic width (BW) and direct bone level (DBL-measured from FRP to bone level which was done after flap reflection, before and after ostectomy). All measurements were performed using a custom grooved acrylic stent and recorded using a University of North Carolina (UNC) 15 probe (Hu-friedy, USA). At baseline, at 3 and 6 months, these clinical parameters were analyzed at the TS, AS, and NAS sites, respectively. Crown lengthening was performed using a Chu Aesthetic Gauge (Fig. 2) (Hu-Friedy, Chicago, IL) instruments (proportion, bone sounding and crown lengthening gauges) which uses color codes and help in a step by step procedure. Prior to recording of clinical measurements, calibration exercises were done by a single experienced periodontist (HB) within 2 h interval and when the values were compared, the reproducibility was 90% then the values were considered accurate.[6]

Primary and Secondary outcomes: The study's major outcomes were BS, BW, RAL, and GM, while supplementary outcomes included PI, GI, and PD.

Pre-Surgical Procedure: After completion of recruitment of patients, pre-surgical photographs were taken. Further phase I therapy (scaling and root planing) was thoroughly performed using ultrasonic scalers and curettes. Later on patients were recalled for re-evaluation and PCL after 8 weeks of phase I therapy. Fig. 1 depicts the armamentarium utilized in the present study.

6. Surgical and post-surgical procedure

After achievement of profound local anesthesia by local infiltrations in and around the surgical site ((2% Lignocaine hydrochloride with 1:80,000 adrenaline) Lidocaine ™), Initial baseline values of clinical parameters were measured using the UNC-15 probe, bone sounding was performed using Sounding gauge and BW was determined (Fig's 3a, 3b, 4a and 4b). Then Chu Proportion Gauge (PG) was used to calculate the tooth width-to-length ratio by placing the incisal stop on the incisal edge of the tooth. The length and width of central incisors were represented by the red band, canines by yellow, and lateral incisors by blue. Based on teeth size (proportions) color coded bands were adjusted i.e. horizontal color band should correlate with vertical color band (Fig's 3 and 4) for proper length to width ratio. If the color coded bands did not coincide with existing tooth proportions, a diagnosis of width to length discrepancy was made. Next, bleeding points were established as guided by the Chu-proportion gauge (Fig's 3c and 4c). External bevel gingivectomy was then performed to achieve the ideal anatomic crown length (Fig's 3d, 4d, 4e and 4f). A full thickness flap was reflected, and Chu biologic perio-gauge was used to achieve the proper mid-facial clinical and biologic crown length simultaneously as it had a preset mid-facial dentogingival measurement of 3 mm. The color codes on shorter arm aided in determining the clinical crown length and those on longer arm represented biologic crown length, hence facilitating in determining the exact amount of bone to be resected (Fig. 3e). Further, flaps were then approximated with sutures 3.0 non-resorbable silk sutures (Fig. 3f) (Mersilk, Ethicon, Jhonson and Jhonson Pvt Ltd, New Delhi, India) and a periodontal dressing (COE-PAK™) (Fig. 3g) was placed. Post operatively, for control of infection Amoxicillin 500 mg thrice daily for 5 days and Diclomol for pain control twice daily were prescribed on day 1 and on SOS basis for remaining 4 days (see Fig. 4).

Patients were recalled after 10 days for suture removal (Fig's 3h and

Fig. 1. Show the armamentarium used in the study.

Fig. 2. Shows the image of Chu Aesthetic Gauges.

4 g) and were kept on a regular follow up. Post-operative measurements were taken at 6 months (Fig. 3i) and final prosthesis were given for some cases at three months and some at 6 months post surgically (Fig's 3j, 3k, 3l, 4h and 4i).

Statistical Analysis: The collected data was converted to a Microsoft Office Excel spreadsheet and statistical analysis was performed using IBM statistical package for social sciences (SPSS) version 22.0 (IBM Corp., Armonk, NY, USA) private limited, Chicago, USA. The mean and standard deviations were used to express all of the data. One way Anova test was used to determine if there was a significant difference ($p < 0.05$) in the mean of the study groups at baseline, 3 months, and 6 months. For pair wise comparisons Post hoc Tukey's test was performed to determine statistical significance at different time periods. P value < 0.05 was considered to be statistically significant.

7. Results

Regarding PI & GI at three sites, mean values were gradually declined from baseline, 3 and 6 months and were statistically significant when means were compared from base line to 3 and 6 months by one way anova (Table 1). While comparisons at different time intervals using post hoc tukey's test for TS, AS and NAS, values were statistically significant for PI ($p = 0.00$*), while GI was significant for baseline to 3 and baseline to 6 months ($p = 0.00$*) and non-significant ($p = 0.72$#) at 3–6 months comparison (Table 2).

In case of position of GM and RAL at all the 3 sites after PCL and osseous re-contouring, comparisons from baseline to 3 months and baseline to 6 months values were statistically significant ($p = 0.00$*) (Table 3). In Table 4 when comparing at different time intervals in using post hoc tukeys, values were statistically significant at baseline to 3 and baseline to 6 months for both PGM and RAL ($p = 0.00$*) at TS, AS and NAS. While non-significance was recorded at 3–6 months comparison for PGM (TS- $p = 0.624$#, AS- $p = 0.741$#, NAS- $p = 0.307$#) and RAL (TS- $p = 0.135$#, AS- $p = 0.170$#, NAS- $p = 0.70$#).

In Table 5 for BS, BW and PD all 3 sites values were statistically significant when compared from baseline to 3 and baseline to 6 months post-operatively ($p = 0.00$*). For time wise comparisons in Table 6, values were statistically significant for baseline to 3 and baseline to 6 months for TS, AS and NAS sites ($p = 0.00$*). While results were non-significant for 3–6 months comparison in BS (TS- $p = 0.122$#, AS- $p = 0.233$#, NAS- $p = 0.131$#), BW (TS- $p = 0.987$#, AS- p-1.00#, NAS p $= 1.00$#) and PD (TS- $p = 0.506$#, AS- $p = 0.504$#, NAS p $= 0.774$#).

Fig. 3. (a–i) Show the step wise surgical procedure form baseline to suture removal, (3j) Final prosthesis on cast k) 6 months post-operative clinical picture with final prosthesis, (3i) shows the relocation of gingival margin from base line using Chu aesthetic gauge.

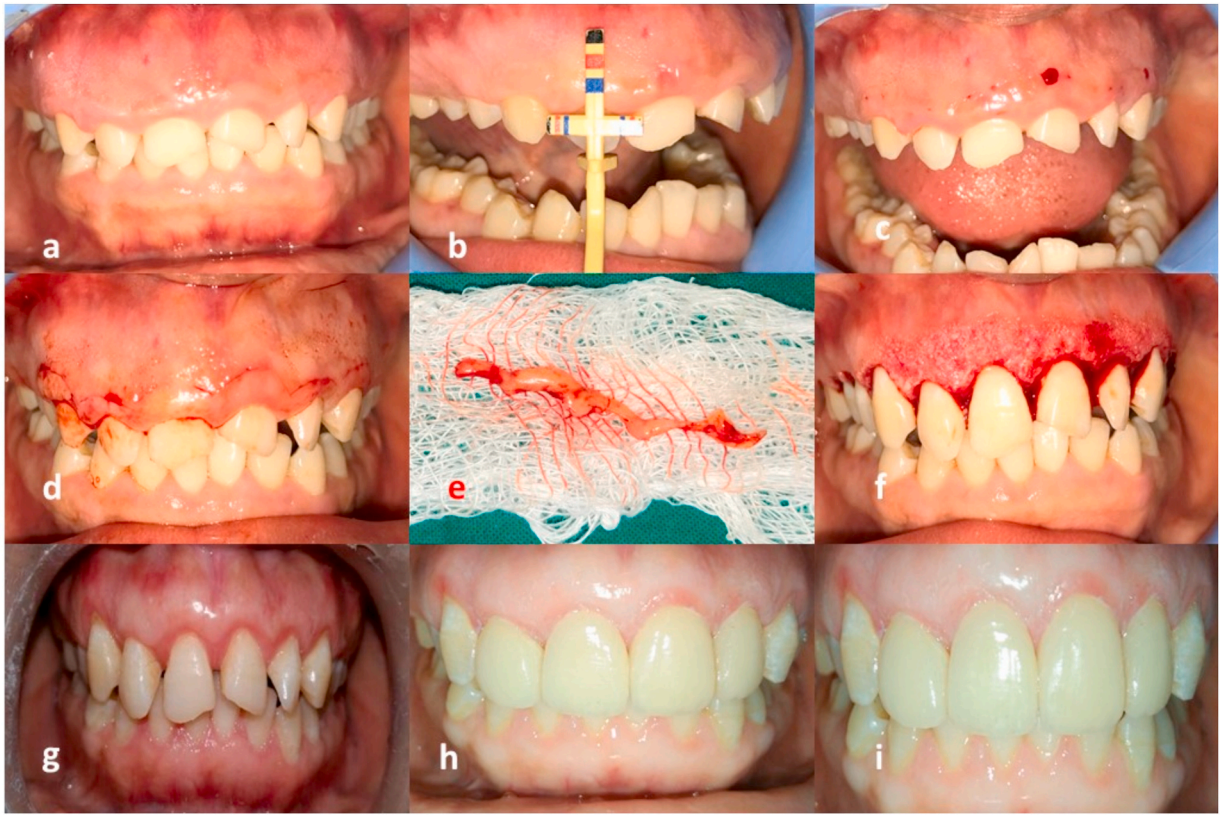

Fig. 4. Show the step wise surgical procedure form baseline pre-op to Immediate Post-op (4a-4f); (4 g) depicts the 10 days post-op; (4h and 4i) 3 and 6 months post-operative.

Table 1
Shows significant comparison of the plaque and gingival index values on three surfaces of teeth at baseline, 3months and 6 months by one way Anova test.

Time Period	Plaque Index (PI)			Gingival Index (GI)		
Baseline	**TS Mean ± S.D**	**AS Mean ± S.D**	**NAS Mean ± S.D**	**TS Mean ± S.D**	**AS Mean ± S.D**	**NAS Mean ± S.D**
	1.38 ± 0.59	1.38 ± 0.59	1.39 ± 0.60	0.91 ± 0.29	0.91 ± 0.29	0.91 ± 0.29
3months	0.81 ± 0.41	0.81 ± 0.4	0.8 ± 0.39	0.09 ± 0.29	0.09 ± 0.29	0.09 ± 0.29
6 months	0.15 ± 0.25	0.15 ± 0.25	0.15 ± 0.25	0 ± 0	0 ± 0	0 ± 0
P value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*

TS- Treated sites, AS- Adjacent sites, NAS- non-adjacent sites, * indicates statistical significance, GI- Gingival Index, PI- Plaque Index, Mean and SD– Mean and Standard Deviations.

Table 2
Depicts the post hoc tukey's significant values for plaque and gingival indices when compared from baseline to 3 months, baseline to 6 months and 3 months–6 months.

Clinical Parameters	Time wise Comparisons		Significance.
Plaque Index TS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.000*
Plaque Index AS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.000*
Plaque Index NAS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.000*
Gingival Index TS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.072#
Gingival Index AS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.072#
Gingival Index NAS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.072#

TS- Treated sites, AS- Adjacent sites, NAS- non-adjacent sites, * indicates statistical significance, # considered Non-Significant ($p > 0.05$), GI- Gingival Index, PI- Plaque Index.

Table 3
Shows the significant comparisons of position of gingival margin and relative attachment level on three surfaces of teeth at baseline, 3 and 6 months by one way Anova test.

Time Period	Position of gingival margin (PGM)			Relative attachment level (RAL)		
Baseline	**TS Mean ± S.D**	**AS Mean ± S.D**	**NAS Mean ± S.D**	**TS Mean ± S.D**	**AS Mean ± S.D**	**NAS Mean ± S.D**
	11.95 ± 1.01	11.94 ± 0.94	12.13 ± 0.95	11.03 ± 0.73	10.95 ± 0.56	11.0 ± 0.55
3months	13.89 ± 1.01	13.73 ± 0.9	14.08 ± 0.9	12.15 ± 0.42	12.15 ± 0.43	12.19 ± 0.44
6 months	13.72 ± 1.12	13.61 ± 1.03	13.83 ± 1.03	11.96 ± 0.49	12 ± 0.5	12 ± 0.49
P value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*

*$p < 0.05$, 0.001 was considered statistically significant, PGM-position of gingival margin, RAL-relative attachment level, Mean SD– Mean and Standard Deviations, TS- Treated sites, AS- Adjacent sites, NAS- non-adjacent sites.

Table 4
Depicts the post hoc tukey's significant values for position of gingival margin and relative attachment level for different sites when compared at baseline to 3 months, baseline to 6 months and 3 months–6 months.

Clinical Parameters	Time wise Comparisons		Significant Values.
Position of Gingival Margin TS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.624#
Position of Gingival Margin AS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.741#
Position of Gingival Margin NAS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.307#
Relative Attachment Level TS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.135#
Relative Attachment Level AS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.170#
Relative Attachment Level NAS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.070#

*$p < 0.05$, 0.001 was considered statistically significant, # considered Non-Significant ($p > 0.05$) PGM-position of gingival margin, RAL-relative attachment level, Mean SD– Mean and Standard Deviations, TS- Treated sites, AS-Adjacent sites, NAS- non-adjacent sites.

8. Discussion

In the present study re-evaluation was done at 8 weeks after the Phase-I therapy as tissues will complete healing between 6 and 8 weeks to achieve a firm and resilient condition with increased pliability for surgical tissue manipulation.

Periodontal surgery occupies an important place in modern aesthetic dentistry. The main indications for anterior PCL are exposure of anatomical crowns, reduction of asymmetry between contralateral teeth, and reduction of excessive gingival exposure.[12] Aesthetic PCL is not suitable for the treatment of lengthened teeth due to periodontal disease or gingival recession. For restorative purposes, there is no clarity on the amount of dental tissue that must be coronal exposed in relation to bone crest.[8]Many investigations show that the bone and soft tissue are frequently undercut, causing biologic width violations. In most cases, a space of 3 mm between the osseous crest and the final restorative margin after a crown-lengthening surgery is considered ideal.[13–17] This 3 mm contains an upper connective tissue attachment of 1 mm, a junctional epithelium of 1 mm, and a furrow depth of 1 mm.[17] In this study, the amount of bone reduction was directed by the CL gauge, which had pre-set color coded marks at 3 mm, ensuring a 3 mm osseous reduction from the clinical crown.[6,16] As much number of studies were not performed present study results were compared with the existing data.

Surgical sites treated in the present study were approximated with 3–0 non-resorbable silk sutures as they were readily available, easy usage and increased tensile strength.[18] In the present study, a statistically significant decrease in PI and GI scores were recorded from baseline to 3 and 6months sharing a common agreement with study conducted by Nautiyal A et al.,[6] and Shobha KS et al.,[18] where they concluded no significant change in PI and GI at the TS, AS and NAS. While coming to mean values of PI and GI ranged from 1.2 to 1.53 and 1.2 to 1.33, respectively following the similar study protocol. This might be due to post-operative use of Chlorhexidine gluconate mouth wash and strict oral hygiene instructions explained to patients to maintain a good oral hygiene, helped in lower PI and GI scores thus, lower plaque accumulation led to decreased gingival inflammation.[19]

The position of GM shifted more apically from baseline to 3 and 6 months but this difference was found to be non-significant when compared from 3 to 6 months. These findings were in accordance with previous studies conducted by Nautiyal A et al.,[6] Lanning et al.,[8] and

Table 5
Show the significant comparisons of mean and standard deviations of bone sounding, biologic width and probing depth on three surfaces at baseline, 3 months and 6 months.

Time Period	Bone sounding (BS)			Biological width (BW)			Probing depth (PD)		
Baseline	**TS**	**AS**	**NAS**	**TS**	**AS**	**NAS**	**TS**	**AS**	**NAS**
	Mean ± S.D	**Mean ± S.D**	**Mean ± S.D**	**Mean ± S.D**	**Mean ± S.D**	**Mean ± S.D**	**Mean ± S.D**	**Mean ± S.D**	**Mean ± S.D**
	3.89 ± 1.11	3.84 ± 1.17	3.88 ± 1.18	2.44 ± 0.64	2.36 ± 0.72	2.41 ± 0.64	1.82 ± 0.68	1.86 ± 0.71	1.83 ± 0.72
3months	5.14 ± 1.1	5.11 ± 1.0	5.13 ± 1.07	1.77 ± 0.56	1.69 ± 0.56	1.73 ± 0.51	1.16 ± 0.29	1.17 ± 0.29	1.13 ± 0.26
6months	5.56 ± 1.11	5.48 ± 1.07	5.5 ± 1.06	1.75 ± 0.53	1.69 ± 0.56	1.73 ± 0.51	1.08 ± 0.25	1.07 ± 0.25	1.08 ± 0.25
P value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*

*$p < 0.05$, 0.001 was considered statistically significant, BS- Bone Sounding, BW- Biologic Width, PD- Probing Depth, TS- Treated sites, AS- Adjacent sites, NAS- non-adjacent sites.

Table 6
Depicts the post hock tukey's significant values at different time intervals for bone sounding biologic width and pocket depth.

Clinical Parameters	Time wise Comparisons		Significant Values.
Bone Sounding TS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.122#
Bone Sounding AS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.233
Bone Sounding NAS	**Baseline**	**3 months**	.000*
		6 months	.000*
	3 months	**6 months**	.131#
Biologic Width TS	**Baseline**	**3 months**	.102#
		6 months	.102#
	3 months	**6 months**	.102#
Biologic Width AS	**Baseline**	**3 months**	.109#
		6 months	.109#
	3 months	**6 months**	.109#
Biologic Width NAS	**Baseline**	**3 months**	.098#
		6 months	.098#
	3 months	**6 months**	.098#
Pocket Depth TS	**Baseline**	**3 months**	.0798#
		6 months	.0798#
	3 months	**6 months**	.0798#
Pocket Depth AS	**Baseline**	**3 months**	.0824#
		6 months	.0824#
	3 months	**6 months**	.0824#
Pocket Depth NAS	**Baseline**	**3 months**	.0824#
		6 months	.000*
	3 months	**6 months**	.307#

*$p < 0.05$, 0.001 was considered statistically significant, # considered Non-Significant ($p > 0.05$) BS- Bone Sounding, BW- Biologic Width, PD- Probing Depth, TS- Treated sites, AS- Adjacent sites, NAS- non-adjacent sites.

Shobha KS et al.,[18] The reason may be partly related to the surgical technique, early soft tissue maturation & stabilization after surgery and longer course of bone remodeling. The amount of bone resected at TS was based on the location of the intended prosthetic margin and the original length of the biological width. While coming to NAS there was an apical shift of GM in this area which is in contrast with previous studies conducted by Lanning et al.,[6] Shobha KS et al.,[18] Bragger U et al.,[20] and Arora R et al.,[21] where there was no GM shift of observed at NAS. This observed effect might be due to remodeling of hard and soft tissue, whose effect is not limited to the surgical site only. The surgical trauma appears to have remodeling effect on the neighboring local environment also, encompassing a broader area and can also be attributed to the difference of interpretation of data.

The RAL for TS, AS and NAS sites were statistically significant when compared from baseline to 3 and 6 months. Change in RAL from 3 to 6 months' time period was found to be non-significant for TS, AS and NAS. Similar results were obtained in the study conducted by Bagger U et al.,[20] where they concluded that, The mean level of probe attachment to the studied tooth decreased statistically significantly after surgical extension of clinical crowns, but there was no significant change between and 6 weeks and 6 months postoperatively. There were no significant differences between baseline and 6 months at the control sites. This can be attributed to better healing outcomes of gingival tissue post-surgically and more apical repositioning of BW has helped in gain of RAL.

The PD after surgery was significant from baseline to 3 and 6 months at any of the sites, and while comparing from baseline to 6 months at NAS value was significant during time variations. Present study results were in harmony with study conducted by Nautiyal A et al.,[6] and Silness & Loe[10,11] where PD measurements were not significantly different at all sites from pre and post-operative time intervals. These variations in PD might be due to variation in the preparation of osteotomy sites as amount of bone removal were different at different areas. Moreover post-operative soft and hard tissue healing variations, Inflammation level created for healing were also inevitable and cannot be controlled or assumed.[22]

The use of stents for clinical parameter testing was advantageous in this investigation. As a result, assistance with probe insertion and angulation is provided, as well as reproducible measuring locations.[23] Badersten A et al.,[24] and Clark DC et al.,[25] both endorse the use of reference stents in situations when they increase reliability and reproducibility over CEJ measurements. In present study, BS and BW values were increased statistically significant from baseline to 3 months and baseline to 6 months. Non-significant values recorded at 3–6 month time interval. These results are in similarity with a recent study conducted by Nautiyal A et al.,[6] and Shobha KS et al.,[18] where they recorded statistical significance at TS and AS. The bone sounding gauge was chosen as the method for acquiring all clinical data throughout time because it was more practicable in getting measurements, particularly bone level by *trans*-gingival probing.

There is a necessity of observing the changes of soft and hard tissues so that, stabilization can be recorded over on going follow up time frame when a final prosthetic restoration is planned in an aesthetic area. Thus ideal time should always be assessed for giving a final restoration.[26] According to studies done by Lanning et al.,[17] and Shobha KS et al.,[18] a restoration of BW after surgical crown extension takes at least six months. Further two research papers by Herrero F et al.,[27] and Bragger U et al.,[20] also confirmed this time frame.

In the present study contrasting results were recorded, where BW got stabilized at the 3rd month interval so, final restoration can be advised to the patient 3 months post-operatively. This in accordance with study performed by Nautiyal A et al.,[6] where they concluded that clinical parameters got stabilized at 3 months post-operatively. These study results were in turn supported by Paul Fletcher et al.,[5] also where they concluded that osseous remodeling continuous till 12 months, soft tissue heals by 8 weeks so, The final restoration can be placed times satisfactorily within 8–12 weeks after crown lengthening if the gingival contour has stabilized and crown margins are inserted traumatically intra-crevicular. Further below are the results comparisons of present study with recent clinical crown lengthening trials.

Study done by Poddar N et al.,[28] stated a non-significant ($p = 0.126$) GI values when compared from baseline to 3 months which is in contrast with present study. Further for clinical parameters like PGM, PD, RAL and BW values were significant for comparisons from baseline to 3

month which is in accordance with present study where significance was recorded from baseline to 3 and 6 months but 3–6 months comparisons were non-significant. This shows the stability of the tissues after 3 months and rehabilitation can be done 3 months after the surgical CL.

Present study results were in accordance with study done by Dominguez A et al.,[29] where they stated that the stable GM position 3 months post-operatively. They also concluded that while performing aesthetic CL procedure, if flap was undermined up to MGJ with greater than 3 mm distance more stable GM was achieved. Major differences in present study was, we have used Chu aesthetic gauges for measuring soft and hard tissue parameters while those authors measured only the levels of GM pre and post-surgically with conventional periodontal probe.

Current study results were also in accordance with a recent systematic review done by Altayab W et al.,[30] where they concluded that adequate healing time of 3 months should be given in order to periodontal tissues in order to achieve stable and predictable results for restoring the surgical area with permanent restorations. They also concluded that rebound of coronal margin can occur with crown lengthening surgery (CLS) and phenotype of periodontium with surgery alters the procedural morbidity, healing time and GM.

Present study results were also in accordance with study done by Altayab W et al.,[31] where they performed laser assisted (Er,Cr:YSGG) aesthetic crown lengthening open flap and flapless approaches and concluded that laser assisted aesthetic CL provided a predictable out come and aesthetic restorative opportunity for clinicians. They also reported the stable gingival margin with no significance and 3 and 9 months. Thus, we can restore the surgical site with final prosthesis 3 months post-surgically due to a stable GM. Major difference between the studies was that present study used a Chu aesthetic gauge while Altayab W et al.,[31] used Laser which is a very expensive instrument whereas gauges are relatively cheaper and regular ease of use.

Limitations of the present study might be smaller sample size. In the present study comparisons of sites by dividing into groups were not performed which might alter the results of the study. Larger sample size with long term follow ups, randomized controlled trials with conventional surgical technique as control group will allow us to know the better treatment outcomes. Shorter follow up is another limitation as alterations of tissues could be assessed over a period of time. Only Maxillary anterior teeth were considered in the present study, if lower anteriors were also included and surgeries were performed better comparisons would have enhanced the results of present study. Chu-Aesthetic gauges cannot be used in case of malocclusion conditions such as crowding and anatomic alterations of teeth positions. These gauges are used only for anterior and cannot be used to assess the levels of posterior teeth.

9. Conclusion

Thus within limitations of present study it can be concluded that, utilization of Chu Aesthetic gauges showed an additional benefit of ideal crown lengthening of surgical site with a good visual perception and controlled removal of soft and hard tissues. It can also be stated that all the positional changes of clinical parameters will get stabilized by 3 months and would be rearranged to a greater equilibrium at 6 months. Further, present study will also conclude that final restoration can be given to patient after 3 months of crown lengthening surgery.

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Ethical approval

IDS/ETHCC/16/08.

Declaration of competing interest

Nil.

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