# The Impact of Using 3D Printed Surgical Guided Crown Lengthening in Treatment of Excessive Gingival Display: A Randomized Clinical Study

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## Abstract

**Background:** Three-dimensional (3D) technology has been utilized in the production of surgical guides, reducing operating time and minimizing complication rates, hence enhancing cases satisfaction and acceptance. The investigation aimed to compare the 3D printed surgical guided crown lengthening versus the conventional surgical technique in the management of excessive gingival display (EGD) (gummy smile).

**Methods:** This randomized clinical investigation has been performed on 24 cases aged from 18 to 49 years old, both genders, with EGD. Cases have been separated into two equal groups: Group I: managed by conventional surgical crown lengthening and Group II: treated by three-dimensional printed surgical guided crown lengthening.

**Results:** There was a significant elevation in biological width measurements from two to four and four to six months. Bone level and crown length measurement after six months showed significantly higher value compared to baseline measurement. The mean gingival margin level and proping pocket depth measurement after six months were significantly reduced value than baseline measurement (P-value under 0.05). Operation times were significantly longer in group I than group II (P-value under 0.001). Patient satisfaction was significantly different between both groups. After 24 hours, two weeks, group I illustrated a significantly higher pain score than group II ($P<0.05$).

**Conclusions:** Digitally assisted surgical esthetic crown lengthening (ECL) exhibited superior clinical outcomes over conventional technique on the level of position of post-operative gingival margin and bone level. Digitally assisted surgical ECL appeared to produce less post-operative pain, more acceptance and satisfaction by the patient and shorten the operating time.

**Keywords:** Three-Dimensional, Crown Lengthening, Excessive Gingival Display, Proping Pocket Depth

## Introduction:

Excessive gingival display (EGD), sometimes referred to as a gummy smile, is characterized by the visibility of over two millimetres of gingiva throughout maximum smiling. It is deemed unesthetic according to aesthetic standards, needing attention. The origins of eexcessive gingival display may be skeletal, as shown in vertical maxillary excess, muscular, as seen in short or hypertonic upper lips, or due to dentogingival abnormalities such as altered passive eruption (APE), or a combination of these causes [1].

APE is the most prevalent cause of this condition, which occurs when the gingival margin is situated in a more coronal region. This is due to the failure of the passive stage of tooth eruption, which results in a clinical crown that is very short. In cases of altered passive eruption, the optimal management would be crown lengthening to rise the length of the clinical crown while concurrently diminishing the excessive gingival display. The type of

crown lengthening technique is to be carried out if the only reason for the procedure is to minimize excessive gingival display, and no restorations will be utilized in adjunction based on the width of the keratinized gingiva and the association of the alveolar crest to the cementoenamel junction (CEJ), so gingivectomy with or without ostecotomy has been established as the therapy of choice of EGD. These procedures, on the other hand, have the potential to be unstable and unexpected; in certain cases, the gingiva may regrow and relapse either completely or incompletely, while in other cases, the gingiva may retreat beyond the levels to which it was regulated [2].

These modalities consisted of utilization of surgical gauges, hand-fabricated stents, digitally guided surgical stents and periodontal measurements. Although each of these techniques demonstrated an improvement in the stability and results, digitally guided surgical stents are theoretically the most efficient and precise. This is because they are guided by the pre-surgical bone levels determined on the cone beam computed tomography (CBCT), which eliminates the possibility of human errors occurring throughout the process of taking measurements [3].

For the purpose of determining the quantity of hard and soft tissue that has to be eliminated, the standard tessellation language (STL) data, which were obtained from intraoral scanning or scanning of impressions, merged with digital imaging and communications in medicine (DICOM) files, which were obtained from CBCT in the year 2020. This alignment raises the precision of the printed guide by enabling the observation of the distance from the CEJ to the bone crest and from the gingival margin to the CEJ in millimetres. Moreover, it helps the diagnosis of altered passive eruption and is therefore regarded as an essential tool. Three-dimensional (3D) technology has been utilized for printing surgical guides, reducing the operating time and decreasing the complication rate leading to in higher cases satisfaction and acceptance [4].

There is no consensus that digitally guided esthetic crown lengthening is the optimal method for achieving the best aesthetic and stable outcomes.

The goal of this work was to compare the 3D printed surgical guided crown lengthening versus the conventional surgical technique in treatment of EGD (gummy smile).

## Patients and Methods:

This randomized clinical study has been performed on 24 cases aged from 18 to 49 years old, both sexes, with EGD and sufficient amount of keratinized gingiva with absence of gingival inflammation, absence of pathologic tooth mobility, presence of 20 teeth or more and free from any systemic disease regarding the American dental academy general guidelines for referring dental cases to specialists and other settings for care [5]. The investigation has been performed following permission from the Ethical Committee Al-Azhar University Hospitals, Assiut, Egypt (approval code: AUAREC20230001-01). An informed written consent wahas been attained from the case

Exclusion criteria were smokers, alcohol or drug abuse patients, pregnant, lactating or women on oral contraceptive pills, under orthodontic therapy with altered or delayed passive eruption and under current chemotherapy or radiotherapy.

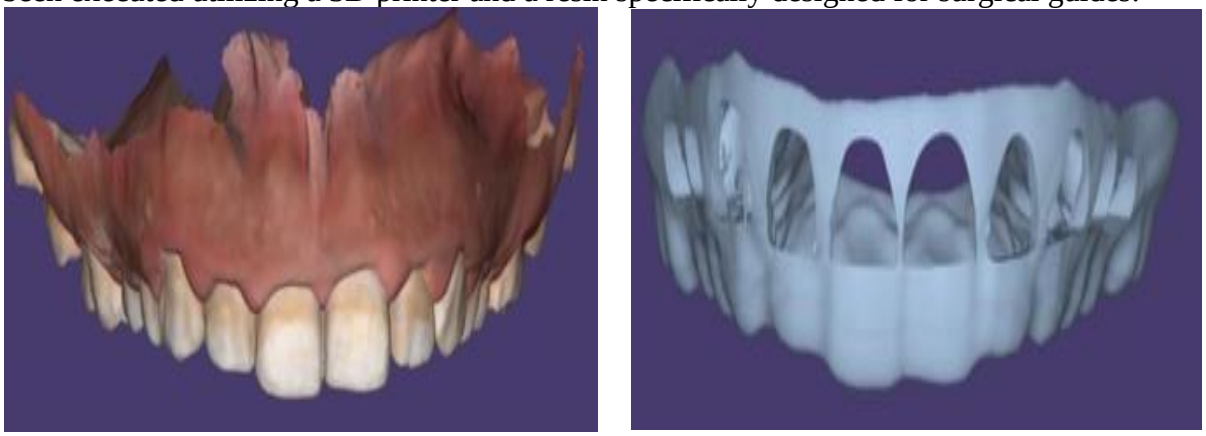
**Randomization**

cases have been separated into two equal groups: Group I: suffering from EGD treated by conventional surgical crown lengthening and Group II: suffering from EGD treated by three-dimensional printed surgical guided crown lengthening.

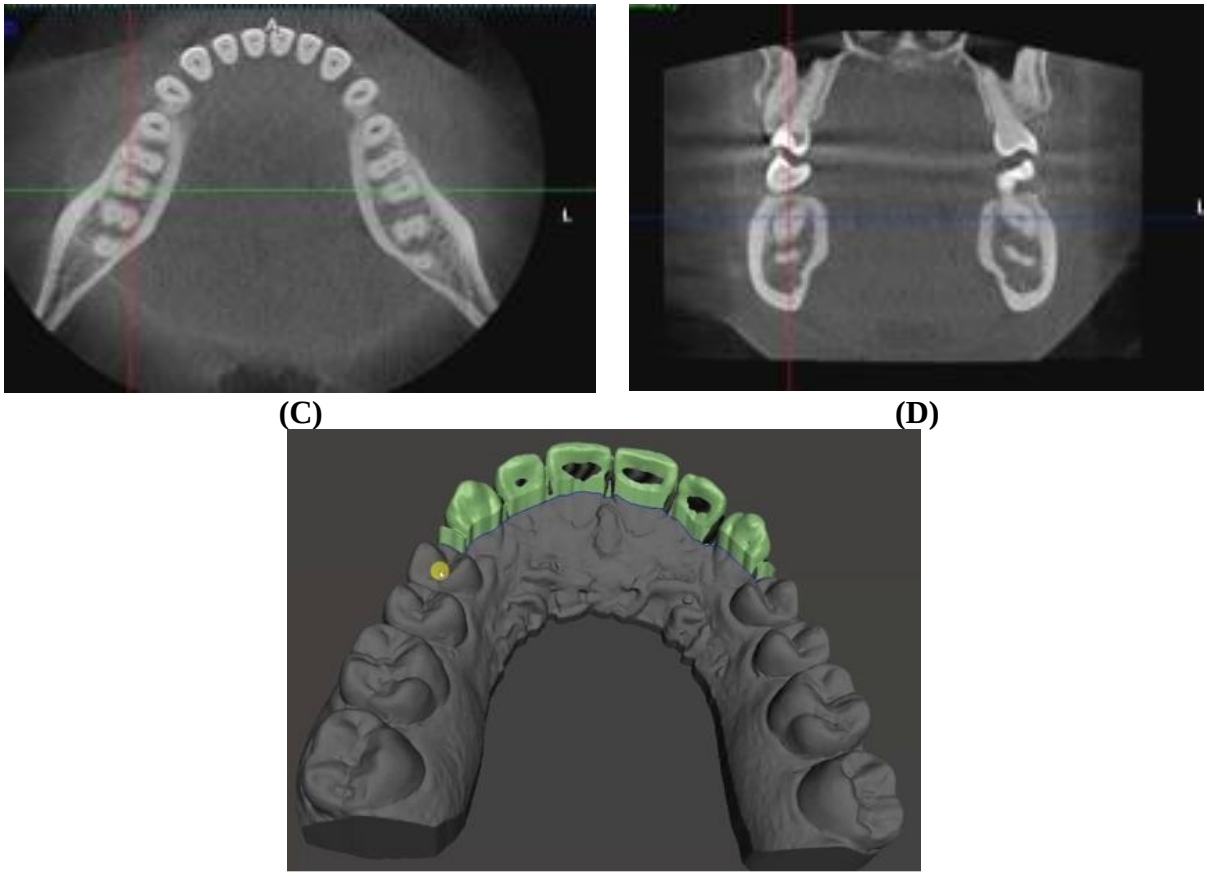
**Fabrication of 3D Printed Surgical Guided for Crown Lengthening [6]**

Intraoral scans for the maxillary arch of the patient were done by utilizing an intraoral scanner (IOS) (**Figure 1, A**) and then the images were imported to the dedicated software. Using a software program the new desired tooth length and the gingival limits were digitally designed by adding layers to each tooth shape, saving the resulting image as standard tessellation language files (**Figure 1, B**). The STL file has been printed with a 3D printer in normal mode, utilizing acrylic resin for dental casts, followed by the creation of a silicone template for aesthetic trial restorations. Following the case's permission of the novel tooth shape and smile a CBCT scan was performed utilizing an appropriate imaging technique **(Figure 1, C and D).** The resultant DICOM data are initially accessed as a multiplanar reconstruction, followed by the identification of the CEJ and the careful determination of the alveolar crest level. The DICOM files of the case ’s dental arch has been converted into STL files.

Autodesk Meshmixer 3.5 software **(Figure 1, E)** have been utilized to overlay all STL files derived from the original intraoral scans, the digital design of the intended tooth morphology, and the CBCT scan acquired post-DICOM conversion to STL format for the surgical planning of the crown-lengthening process. Determination of the necessity for alveoloplasty has been conducted by comparing the limits of hard and soft tissue. In this context, osseous contouring has been executed only in cases where the distance from the primary incision to the alveolar crest was under three millimetres for a thin gingival biotype or four millimetres for a thick gingival biotype. The Autodesk Meshmixer 3.5 program has been utilized to create a surgical guide utilizing the “brush selection” function to delineate an upper band. The primary reference for the surgical guide is the buccal upper band, which averages three millimeters in width, with individual variability influenced by factors like biotype, periodontal condition, or the necessity for ferrule, and which corresponds to the biological width measurement according to the expected digitally designed future location of the gingival margin. The bottom border of the band reveals the place of the first marginal incision, while the upper edge denotes the level to which the alveolar bone crest must be relocated by osteotomy throughout the surgical crown-lengthening procedure. Upon completion of the digital design of the surgical guide, the finalization of the 3D model was achieved utilizing the “Select>Edit>Extrude” sequence tools with the parameters: 1-millimeters offset, 0 harden, 20 density, Constant Direction, and Offset End Type. The "Deform>Smooth" tool can subsequently be utilized to even the edges of the guide. Following the exportation of the resultant STL file, the manufacture of the surgical guide has been executed utilizing a 3D printer and a resin specifically designed for surgical guides.



**(A)** **(B)**



**(C)** **(D)**

**(E)**

**Figure 1: (A) Intraoral scan for the maxillary teeth, (B) exocad software and the standard tessellation language file, (C, D) multi-planar reformation of digital imaging and communications in medicine file and (E) Autodesk meshmixer**

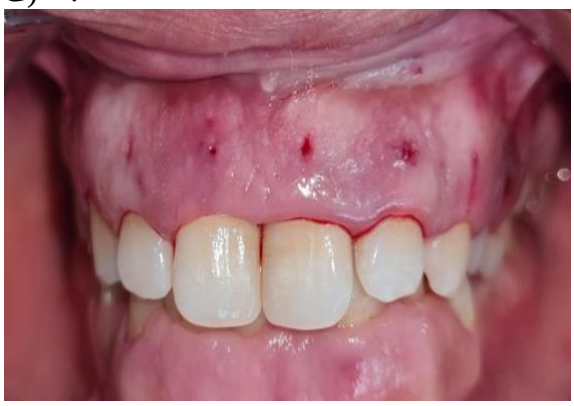
Pre surgical preparation: all patients received phase I periodontal therapy including: patient education and motivation. Mechanical plaque control. Full-mouth scaling and root planing were conducated using hand instrument sickle scaler, gracey curette and ultrasonic devices to remove local deposits such as plaque calculus and other plaque retentive factors.

Surgical Intervention ‘Surgical Phase": the crown lengthening procedures in this study were performed either by gingivectomy only or combination of gingivectomy and osseous contouring procedures. For group I all procedures were done free hand while for group II all procedures were fully guided.

**Group I:** the operative area was anesthetized with 4% articaine 1:100,000 epinephrine by infiltration technique and/ or nerve block technique. Probing pocket depth (PPD) was performed to determine the base of the pockets using William’s graduated periodontal probe then bleeding points which are coincided with the base of the pocket/sulcus were created in the gingiva by using William’s periodontal probe to establish the ideal location of the gingival margin which approximately 1mm coronal to the CEJ (**Figure 2, A**) [7] . Initial bevel incision was made apical to the bleeding point and directed coronally to a point between the base of the pocket and the bone crest (**Figure 2, B**) by scalpel blade No. 15 considering the zenith of the central incisors, lateral incisors, and canines were respectively located 1 mm, 0.4 mm, and 0 mm from the teeth‟ midline. Also, consideration of the vertical location of the margins of central incisors and canines were at the same level. The gingival margins of the

lateral incisors were located 1 mm more coronal than those of the central incisors and canines [7]. The incision beveled approximately 45 degrees to the tooth surface and recreated, as far as possible, the normally festooned pattern of the gingiva, then a sulcular incision was performed, the excised tissue then removed with curettes. Finally, gingivoplasty was performed (**Figure 2, C**) [8]. The surgical side was flushed with saline solution to remove foreign particles.

An initial bevel incision, following CEJ anatomy, was made at each tooth, preserving inter-dental papillae. This was followed by an intra-sulcular incision and elevation of a mucoperiosteal flap (**Figure 2, D**) to the level of the mucogingival junction (MGJ). Bone recontouring was carried out using round bur with copious amounts of normal saline. The bone was thinned until there was a thin layer remaining over the surface. Then any bone ledges were smoothed to aid the repositioning of the flap (**Figure 2, E**). Enough bone was removed to create a 3 mm space measured by periodontal probe. Finally, the flap was repositioned and sutured with single interrupted sutures to stabilize the flap (**Figure 2, F and G**) [9].



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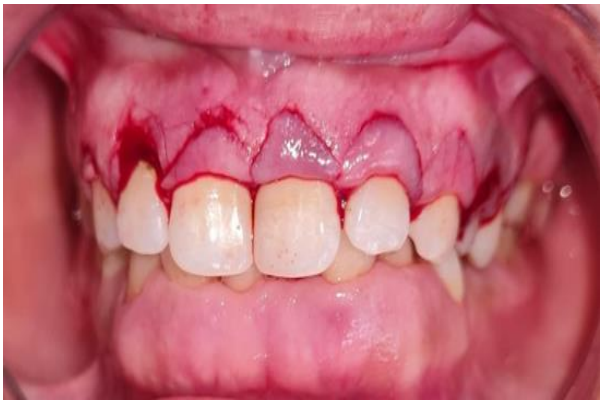

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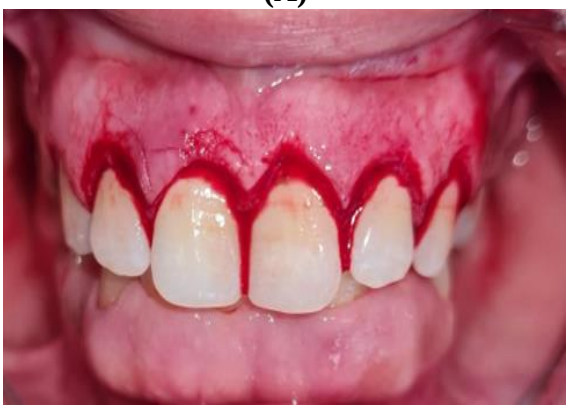

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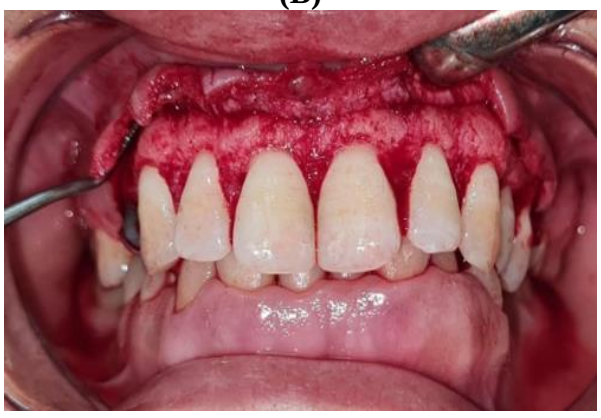

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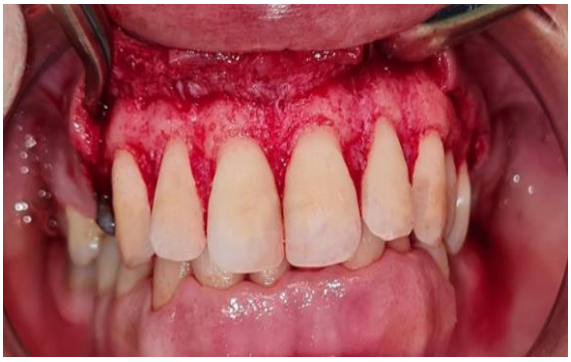

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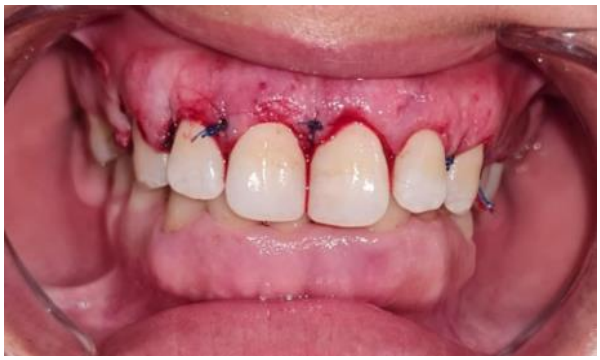

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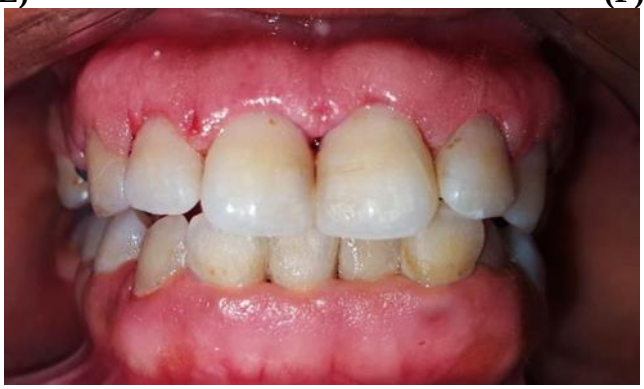


**(G)**

**Figure 2: (A) Bleeding points, (B) the initial bevel incision, (C) after gingival excision, (D) after elevation of the mucoperiosteal flap, (E) after bone recontouring and smoothening, (F) after repositioning of the flap and suturing and (G) after healing and removing the sutures**

**Group II:** The operative area was anesthetized with 4% articaine 1:100,000 epinephrine by infiltration technique and/ or nerve block technique. The incision lines were marked by No.15 blades using the printed guide (**Figure 3, A**). From these marking incision lines; the actual primary incisions were made without the guide. The scalloping bevel incision creating ideal locations of zeniths on the central, lateral, and canines was made. The incision was made considering the zenith of the central incisors, lateral incisors, and canines were respectively located 1 mm, 0.4 mm, and 0 mm from the midline. Also, consideration of the vertical location of the margins of central incisors and canines were at the same level. The gingival margins of the lateral incisors were located 1 mm more coronal than those of the central incisors and canines, then a sulcular incision was performed, the excised tissue then removed with curettes. Finally, gingivoplasty was performed (**Figure 3, B**) [7].

The blades were frequently changed to maintain the cutting efficiency. A full-thickness flap was raised on the buccal surface. Using a guide, the amount of ostectomy was measured (**Figure 3, C**), and the osseous resection was performed, keeping a 3 mm distance between the newly established gingival margin and alveolar crest (**Figure 3, D**). The guide was inserted back and forth to confirm that the reduction was sufficient to avoid any soft tissue rebound. The flap was repositioned and sutured with single interrupted sutures (**Figure 3, E and F**) [10].

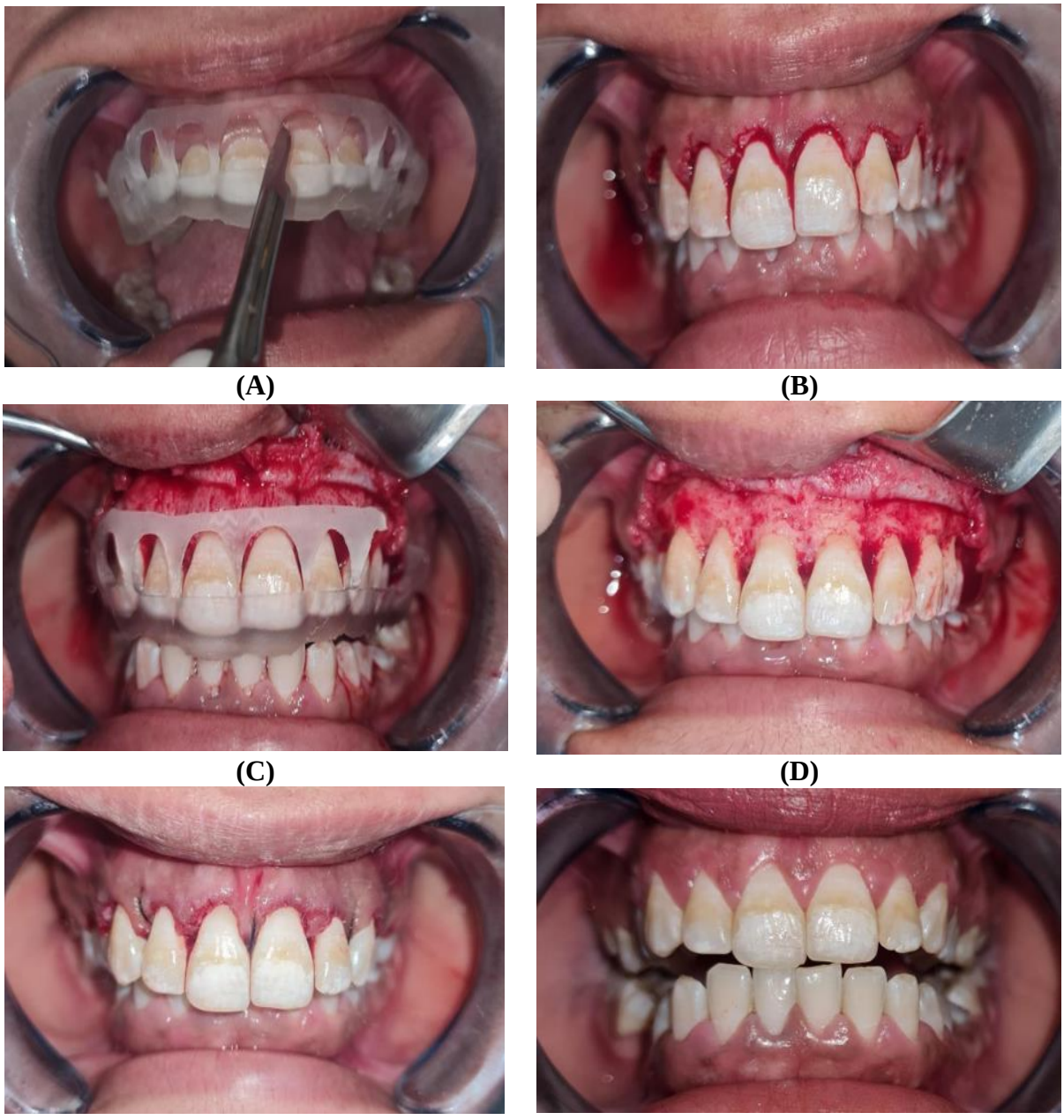


**Figure 3: (A) Marking the licision lines for gingival removal with the guide, (B) after gingival excision, (C) a full-thickness flap was raised on the buccal surface using the guide to measure the amount of ostectomy, (D) osseous resection was performed, (E) after repositioning of the flap and suturing and (F) after healing and removing the sutures**

Postoperative Instructions [11]: medications by antibiotic (amoxicillin/clavulanate potassium) every 12 hours for 1 week and analgesics (Ibuprofen) every 8 hours for 1week were prescribed. The patients were instructed to rinse with chlorhexidine gluconate mouth wash (Chlorhexidine) for 30 seconds/twice daily for 10 days. Soft and cold feeding was recommended during the first post-operative day [12] . Patients were advised to use cold fomentation on the day of operation to reduce edema formation.

Supra-crestal tissue attachment (Biological width): bone sounding for soft tissue and level of the alveolar crest bone determination was performed after administration of a local anesthesia. Periodontal probe is inserted into the sulcus/pocket to measure the sulcus/pocket depth then, the periodontal probe was forced to penetrate trans-gingivally until contact is made with the alveolar crest, perforating the junctional epithelium and gingival connective tissue. (Probing bone level) The full penetration depth of periodontal probe was measured, and calculation of the biological width was done by subtraction of the sulcus/pocket depth from bone level probing measurement [13].

Bone level changes: the relative bone level was measured as the distance between a fixed landmark (CEJ /point in the stent) and the bone crest and recorded before and after the surgical procedures. Bone level was measured by transgingival probing under local anesthesia [14].

Clinical crown length: it was measured as the distance from gingival margin to incisal edge of the tooth on the midbuccal aspect. The measurements were recorded using William‟s graduated periodontal probe [15]. Changes were measured by subtraction of clinical crown height at baseline from the measurement at 2nd,4th and 6th months after surgery.

Position of gingival margin: It was measured as the distance between the free gingival groove and gingival margin on the mid buccal aspect [16]. Changes were measured by subtraction of position of gingival margin at baseline from the 2nd,4th and 6th months after surgery.

PPD: probing the pocket depth was measured by William's graduated periodontal probe as the distances from the free gingival margin to the base of the periodontal pocket at six sites around the teeth pre-operative at baseline, 2nd,4th and 6th months post-operatively [17].

Operation Time: the operating time needed to complete the surgery was recorded on a stopwatch from the time of the first incision till the completion of bone removal [18].

Post operative pain assessment: according to Huskisson's recommendations [19], pain assessment was performed using a Visual Analog Scale (VAS) (fig 23), it consists of equal units from 0 - 10 as follow: Patients were instructed to make a vertical mark between these two end points on the pain as well as the discomfort scale separately at baseline ,1st week,3rd week.

No pain (Zero), slight pain (1-2), moderate trouble pain (3-4), miserable distressing pain (5-6), dreadful horrible intense pain (7-8) and worst possible pain (9-10).

Patient Satisfaction: the esthetic satisfaction perceived by the patients after the treatment was analyzed by a questionnaire. The patients were asked to fill in a questionnaire comprising of questions related to the esthetic change after a week and the expected outcomes related to both the treatment protocols after one month. The evaluation of the treatment outcome by a professional photographer was implemented through a questionnaire. The questions addressed patient satisfaction with smile, amount of gingiva displayed, symptoms, pain, best and worst aspect of the procedure, and whether patient would undergo the procedure again [20].

Gingival index (GI) was used to assess gingival inflammation [21].

Plaque index (PL) was used to assess plaque accumulation around the gingival margin [21]. The degree of plaque accumulation was recorded as follows: no plaque around the gingival margin (zero), a thin film of plaque around the gingival margin.

The primary outcome was an assessment of biological width, bone level changes, crown length, position of gingival margin and probing depth. The secondary outcome was evaluation of operation time, post-operative pain, patient satisfaction, GI and plaque index.

**Sample Size Calculation:**

Using G Power 3 software®. A calculated minimum sample of 24 patients presented with EGD was needed. Eligible patients were assigned in a 1:1 ratio into one of two equal groups to detect an effect size of 0.9 in the mean biological width, bone level changes, crown length, position of gingival margin and probing depth with an error probability of 0.05 and 85% power on a one-tailed test.

**Statistical analysis**

Statistical analysis was done by SPSS v26 (IBM Inc., Chicago, IL, USA). Shapiro-Wilks test and histograms were used to evaluate the normality of the distribution of data. Quantitative parametric variables were presented as mean and standard deviation (SD) and compared between the two groups utilizing unpaired Student's T- test. Quantitative non-parametric data were presented as median and interquartile range (IQR) and were analyzed by Mann Whitney-test. Qualitative variables were presented as frequency and percentage (%) and were analyzed utilizing the Chi-square test or Fisher's exact test when appropriate. A two tailed P value < 0.05 was considered statistically significant.

## Results:

Demographic data were insignificantly different between both groups. **Table 1**

**Table 1: Demographic data of the studied patients**

| | | Group I (n = 12) | Group II (n = 12) | P |
|---|---|---|---|---|
| **Age (years)** | | 29.8(9.2%) | 28.3(7.8%) | 0.688 |
| **Sex** | **Male** | 4(33.3%) | 4(33.3%) | 1 |
| | **Female** | 8(66.7%) | 8(66.7%) | |

Data is presented as frequency (%).

Biological width and crown length at the baseline, after two, four as well as six months were insignificant different between the two groups. There was a significant decrease in biological width and gingival margin level measurements after two months. There was a significant increase in biological width measurements from two to four as well as four to six months. The mean biological width measurement after six months showed no significant difference from base line measurement. There was a significant increase in crown length measurements after two months, from two to four as well as four to six months. The mean crown length measurement after six months showed significantly longer length measurements compared to base line measurement. Mean gingival margin level at baseline was significantly lower in group I than group II (P<0.001). Mean gingival margin level after two, four as well as six months was significantly higher in group I than group II (P<0.05). There was no significant change in gingival margin level measurements from two to four as well as four to six months. The mean gingival margin level measurement after six months was significantly lower value compared to baseline measurement (P<0.05). **Table 2**

**Table 2: Biological width, crown length and gingival margin level measurements of both groups**

| | Group I (n = 12) | Group II (n = 12) | P | Effect size (Partial Eta squared) |
|---|---|---|---|---|
| **Biological width** | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Time** | **Baseline** | 2.02 $^{A}$±0.1 | 1.99 $^{A}$±0.04 | 0.311 | 0.047 |
| | **2 months** | 1.8 $^{C}$±0.06 | 1.78 $^{C}$±0.05 | 0.412 | 0.031 |
| | **4 months** | 1.87 $^{B}$±0.1 | 1.87 $^{B}$±0.05 | 0.854 | 0.002 |
| | **6 months** | 2.01 $^{A}$±0.02 | 2.01 $^{A}$±0.02 | 0.312 | 0.046 |
| **P** | | **<0.001*** | **<0.001*** | | |
| **Effect size (Partial Eta squared)** | | 0.963 | 0.963 | | |
| **Crown length** | | | | | |
| **Time** | **Baseline** | 7.96 $^{D}$±0.42 | 8 $^{D}$±0.29 | 0.745 | 0.005 |
| | **2 months** | 9.38 $^{C}$±0.38 | 9.23 $^{C}$±0.48 | 0.405 | 0.032 |
| | **4 months** | 10.01 $^{B}$±0.33 | 10.09 $^{B}$±0.26 | 0.512 | 0.020 |
| | **6 months** | 10.7 $^{A}$±0.32 | 10.71 $^{A}$±0.26 | 0.953 | 0.0002 |
| **P** | | **<0.001*** | **<0.001*** | | |
| **Effect size (Partial Eta squared)** | | 0.974 | 0.976 | | |
| **Gingival margin level** | | | | | |
| **Time** | **Baseline** | 2.49 $^{A}$±0.31 | 2.97 $^{A}$±0.24 | **<0.001*** | 0.45 |
| | **2 months** | 1.61 $^{B}$±0.24 | 1.14 $^{B}$±0.2 | **<0.001*** | 0.557 |
| | **4 months** | 1.72 $^{B}$±0.22 | 1.28 $^{B}$±0.19 | **<0.001*** | 0.538 |
| | **6 months** | 1.8 $^{B}$±0.19 | 1.33 $^{B}$±0.28 | **<0.001*** | 0.521 |
| **P** | | **<0.001*** | **<0.001*** | | |
| **Effect size (Partial Eta squared)** | | 0.857 | 0.965 | | |

Data are presented as mean ± SD. * Significant P value<0.05.

Bone level, PPD, GI and PI scores at the baseline, after two as well as six months, there was no significant difference between the two groups. There was a significant increase in bone level measurements after two months, from two to four as well as four to six months. The mean bone level measurement after six months showed significantly higher value compared to baseline measurement. There was a significant decrease in PPD measurements after two months followed by a non-significant change from two to four as well as four to six months. The mean PPD after six months showed significantly lower value compared to base line and two months‟ measurements. There was a significant decrease in GI score after two months followed by a statistically significant increase from two to four months. From four to six months, there was no significant change in GI scores. GI and PI scores after six months showed significantly lower value compared to base line scores. There was a significant decrease in PI score after two months. This was followed by a significant increase in PI scores from two to four as well as four to six months. **Table 3**

**Table 3: Bone level, PPD, GI and PI scores measurements of both groups**

| | | **Group I (n = 12)** | **Group II (n = 12)** | **P** | **Effect size (Partial Eta squared)** |
|---|---|---|---|---|---|
| **Bone level** | | | | | |
| **Time** | **Baseline** | 1.08 $^{D}$±0.08 | 1.07 $^{D}$±0.07 | 0.661 | 0.009 |
| | **2 months** | 1.97 $^{C}$±0.07 | 1.98 $^{C}$±0.09 | 0.778 | 0.004 |

| | | | | | |
|---|---|---|---|---|---|
| | **4 months** | 2.09 $^{B}$±0.07 | 2.15 $^{B}$±0.06 | **0.019*** | 0.226 |
| | **6 months** | 2.27 $^{A}$±0.1 | 2.27 $^{A}$±0.1 | 0.980 | 0.00003 |
| **P** | | **<0.001*** | **<0.001*** | | |
| **Effect size (Partial Eta squared)** | | 0.988 | 0.989 | | |
| **PPD** | | | | | |
| **Time** | **Baseline** | 2.82±0.24 | 2.92 $^{A}$±0.42 | 0.472 | 0.024 |
| | **2 months** | 2.64±0.44 | 2.68 $^{B}$±0.29 | 0.820 | 0.002 |
| | **4 months** | 2.54±0.4 | 2.48 $^{BC}$±0.21 | 0.671 | 0.008 |
| | **6 months** | 2.45±0.43 | 2.3 $^{C}$±0.17 | 0.264 | 0.056 |
| **P** | | 0.068 | **0.002*** | | |
| **Effect size (Partial Eta squared)** | | 0.294 | 0.519 | | |
| **GI scores** | | | | | |
| | | | | | Effect size (d) |
| **Time** | **Baseline** | 2.41 ±0.32 | 6 ±1.13 | 0.453 | 0.31 |
| | **2 months** | 0.99 ±0.15 | 0.86±0.17 | 0.056 | 0.844 |
| | **4 months** | 1.31 ±0.18 | 1.33±0.29 | 0.977 | 0.012 |
| | **6 months** | 1.53 ±0.27 | 1.51±0.28 | 0.862 | 0.071 |
| **P** | | **<0.001*** | **<0.001*** | | |
| **Effect size (w)** | | 0.878 | 0.819 | | |
| **PI scores** | | | | | |
| **Time** | **Baseline** | 2.31±0.27 | 2.24±0.26 | 0.488 | 0.286 |
| | **2 months** | 0.94±0.14 | 0.87±0.14 | 0.285 | 0.447 |
| | **4 months** | 1.42±0.28 | 1.31±0.24 | 0.340 | 0.396 |
| | **6 months** | 1.8±0.19 | 1.75±0.19 | 0.312 | 0.422 |
| **P** | | **<0.001*** | **<0.001*** | | |
| **Effect size (w)** | | 0.969 | 0.969 | | |

Data are presented as mean ± SD. * Significant P value<0.05. PPD: proping pocket depth, GI: gingival index, PI: plaque index.

After 24 hours, one as well as two weeks, group I showed a significantly higher pain score than group II (P<0.05). There was a significant decrease in pain score after one week as well as from one to two weeks (P<0.05). Pain scores after two weeks showed significantly lower value compared to 24 hours' score (P<0.05). **Table 4**

**Table 4: Pain scores of both groups**

| | | **Group I (n = 12)** | **Group II (n = 12)** | **P** | **Effect size (d)** |
|---|---|---|---|---|---|
| | | | | | |
| **Time** | **24 hours** | 5.15(4.3 -5.7) $^{A}$ | 4.2(2.7-5.2) $^{A}$ | **0.003*** | 1.551 |
| | **1 week** | 2.85(0.73-4.1) $^{B}$ | 1.21(0.21-2) $^{B}$ | **<0.001*** | 2.297 |
| | **2 weeks** | 0.9(0.3- 1.32) $^{C}$ | 0.24(0.01- 0.86) $^{C}$ | **<0.001*** | 2.178 |
| **P** | | **<0.001*** | **<0.001*** | | |
| **Effect size (w)** | | 0.667 | 0.667 | | |

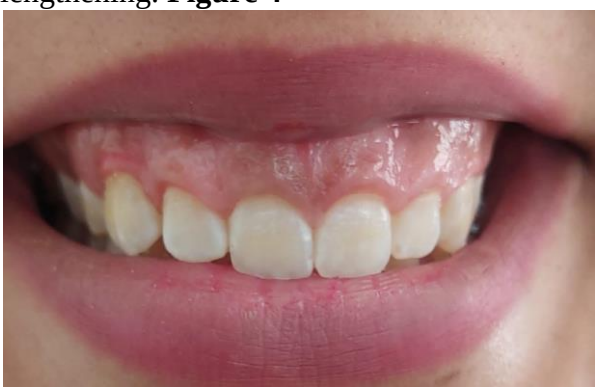
Data is presented as median (IQR). * Significant P value under 0.05.

Operation times were significantly longer in group I compared to group II (P-value under 0.001). Cases satisfaction was significantly variant among both groups. **Table 5**

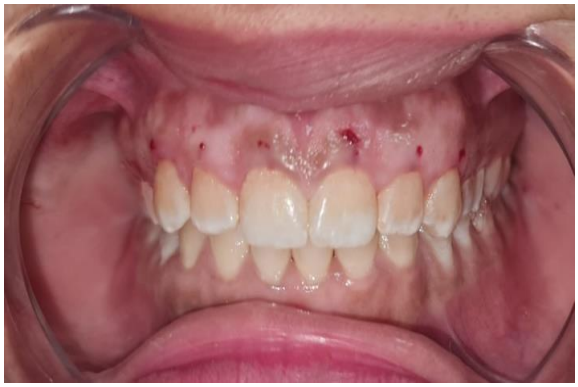
**Table 5: Operation times and patient satisfaction of both groups**

| | Group I (n = 12) | Group II (n = 12) | P | Effect size (d) |
|---|---|---|---|---|
| | | | | |
| **Operation times (minutes)** | 70.1±8.3 | 50.1±4.6 | **<0.001*** | 2.973 |
| **Patient satisfaction** | | | | |
| | | | | **Effect size (v)** |
| **Totally satisfied** | 6(50.0%) | 8(66.7%) | **0.048*** | 0.231 |
| **Partially satisfied** | 3(25.0%) | 3(25.0%) | | |
| **Unsatisfied** | 3(25.0%) | 1(8.3.0%) | | |

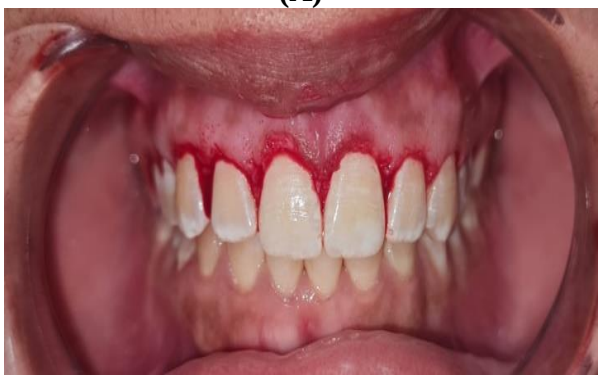
**Case 1:** 24 years old female patient with EGD treated by conventional surgical crown lengthening. **Figure 4**



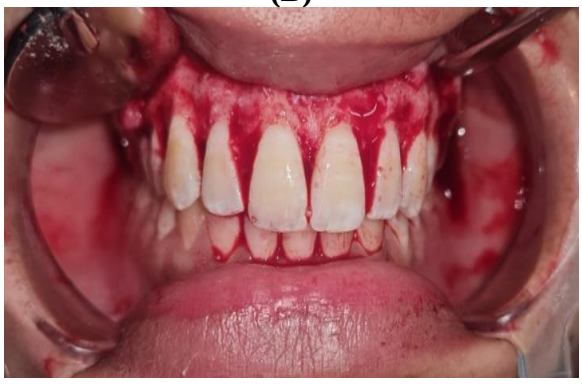
**(A)**



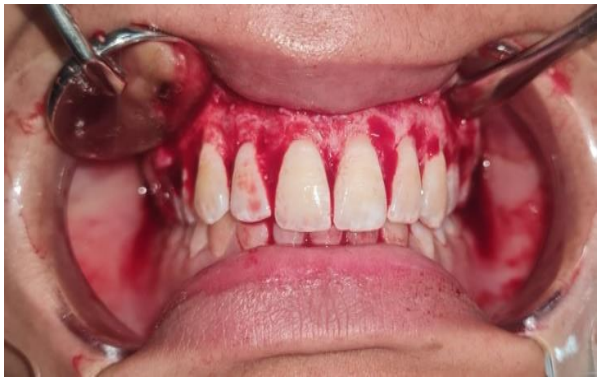
**(B)**



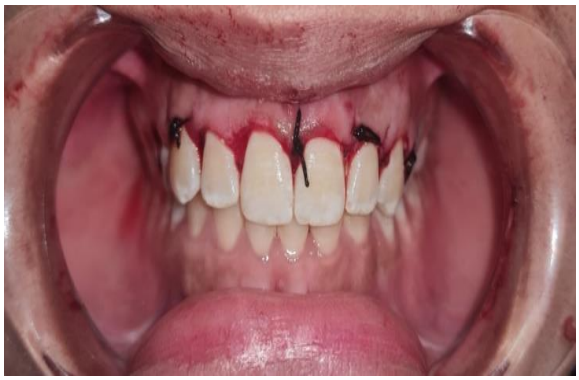
**(C)**



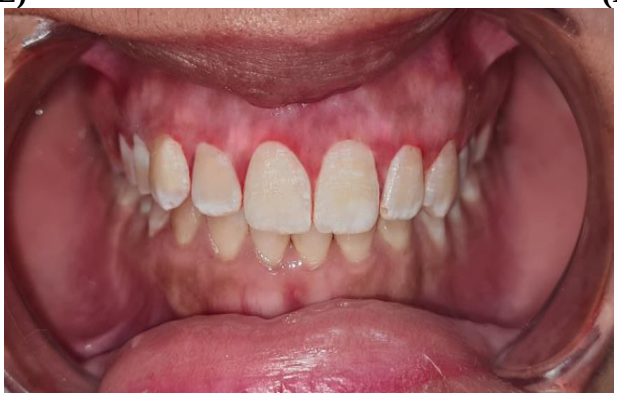
**(D)**



**(E)**



**(F)**

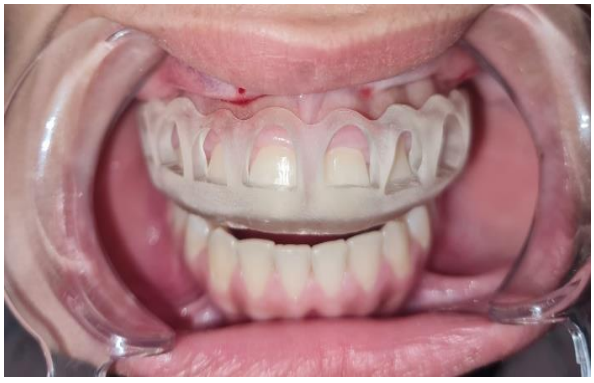


**(G)**

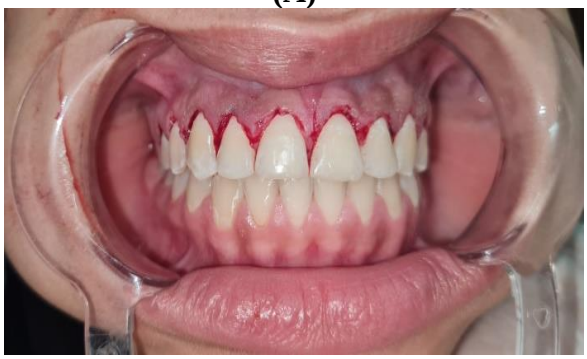
**Figure 4: (A) Pre-operative, (B) bleeding points, (C) after gingivectomy, (D) flap reflection, (E) after osseous removal, (F) suturing and (G) post-operative**

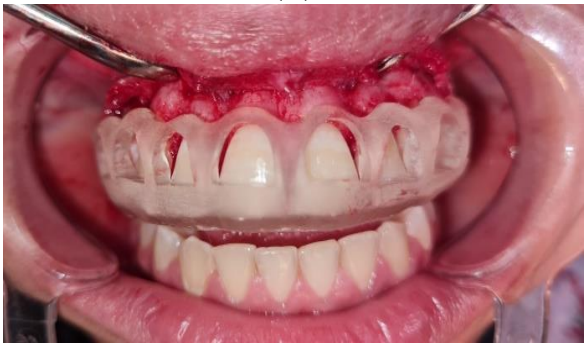
**Case 2:** 22 years old female patient with EGD treated by three-dimensional printed surgical guided crown lengthening. **Figure 5**

**(A)**



**(B)**





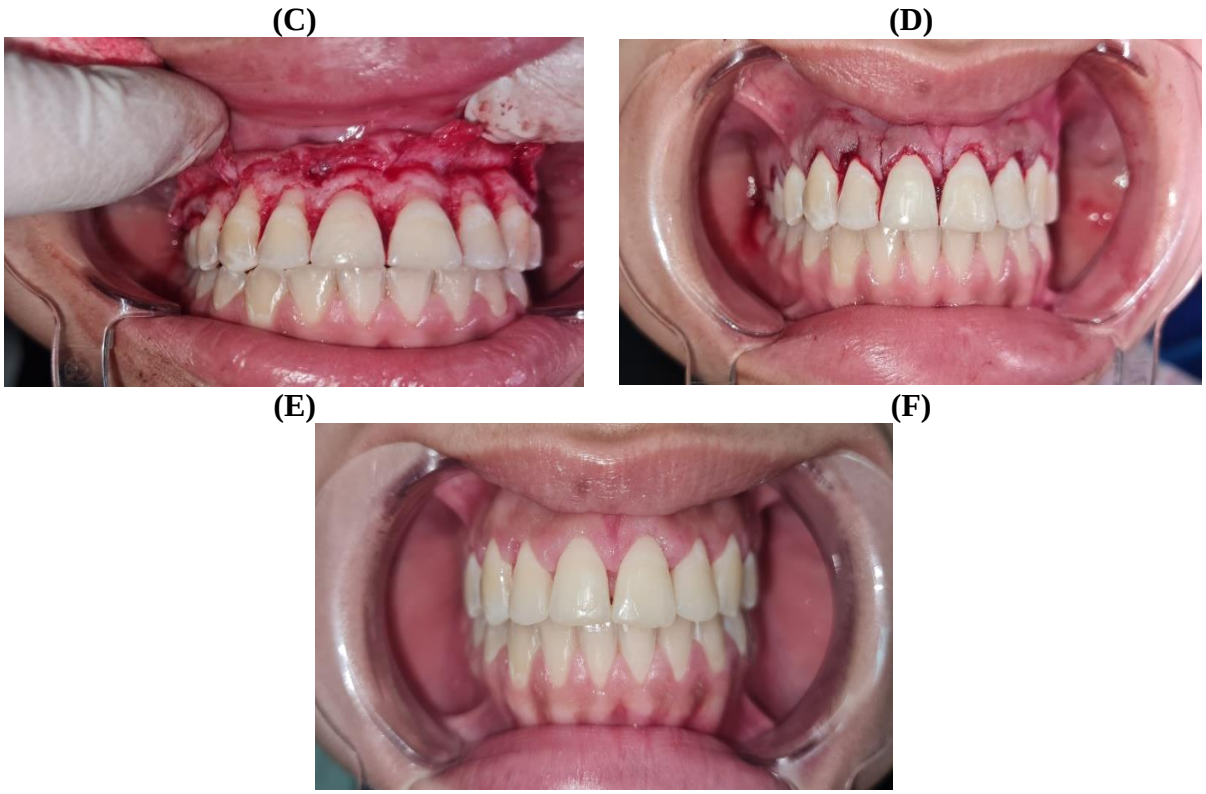



**Figure 5: (A) Pre-operative, (B) guide placement, (C) after gingivectomy, (D) osseous removal with guide, (E) after osseous removal, (F) suturing and (G) post-operative**

## Discussion

In modern dentistry, the goal is to satisfy the expectations of cases and fulfill their dental esthetic needs, all while ensuring that the case's health and function are preserved [22].

Regarding the biological width within each group there was a significant alteration in biological width measurements by time. There was a significant decrease in biological width measurements following two months. This was followed by a significant increase in biological width measurements from two to four as well as four to six months. Between the two groups at base line, after two, four in addition to six months, there was a statistically insignificant variance among both groups.

The biological width at all locations rose from the second month in the current investigation. This is due to a little increase in attachment level and apical dislocation of the bone level. Bone resorption after surgical crown lengthening yields supracrestal tooth structure for connective tissue attachment, facilitating the restoration of the biologic width. The biologic width values at the second month were substantially altered from baseline. The original dimension of biologic width has been restored at managed locations following twelve weeks, regardless of the surgical crown lengthening approach utilized [23, 24]. It has been shown that following surgical crown lengthening, the biologic width at the managed areas was restored to its original vertical dimension within a period of six months. A consistent increase of three millimeters in coronal tooth structure has been detected at the examinations conducted in the third and sixth weeks [25].

The present study found that in both groups, there was a significant alteration in crown length measurements by time. There was a significant increase in crown length measurements

following two months, from two to four as well as four to six months. The mean crown length measurement after six months showed statistically significantly longer length measurements compared to base line measurement. Between groups at base line, after two, four as well as six months, there was no statistically significant difference. These result are in agreement with those who found an insignificant variance among the clinical crown length following esthetic crown lengthening throughout the monitoring periods [2, 26], but in contrary with those who found decrease in crown length among baseline and post operative examination. This decreases from post-surgery to final examination reveals that throughout healing a dislocation of the newly formed soft tissue margin in a coronal direction from post-surgical level had happened [27].

This investigation showed that there was a significant alteration in gingival margin position measurements by time. There was a significant decrease in gingival margin level measurements in both groups after two months. This was followed by non-significant alteration in gingival margin level measurements from two to four as well as four to six months. The mean gingival margin position measurement between groups after six months showed significantly lower value compared to baseline measurement. Between the two groups at base line, group I illustrated significantly reduced mean gingival margin position than group II. After two, four in addition to six months, group I illustrated significantly elevated mean gingival margin level in comparison with group II. These results are in agreement with other investigations, who observed high precision and similar gingival margin stability over at least 6 months in group II [2, 28], but in disagreement to those who found a statistically insignificant variance among the gingival margin stability in the group receiving freehand esthetic crown lengthening versus dual guide-assisted esthetic crown lengthening [29].

Concerning the bone level change in both groups, a significant alteration has been detected in bone level measurements by time. It was indicated that there was a significant elevation in bone level measurements after two months, from two to four as well as four to six months. The mean bone level measurement after six months showed significantly higher value compared to base line measurement. This may be attributed to those who stated that the alveolar crest was reduced, thereby creating 3 mm to the future reconstruction margin. This may suggest that the bone level following operation was apically situated with regard to the location where the flap margin has been sutured [27]. This is because the flap margin was located at a mean distance from the reference point. There was no significant variance among both groups at the beginning of the data collection period, following two months, or following six months. When compared to group II, group I had a significantly reduced mean bone level following a period of four months.

The present work showed no significant change in PPD measurements of the group I by time. Whereas in group II, a significant alteration has been observed in PPD measurements by time. It was indicated that there was a significant decrease in PPD measurements following two months followed by non- significant change from two to four as well as four to six months. However, the mean PPD after six months showed significantly lower value compared to base line and two months' measurements. At baseline, following two, four, and six months, an insignificant variance has been seen among both groups. Similar to the findings of those who discovered a significant variance between the PD at the beginning of the study and the three months and the six-month monitoring period, these findings also appeared. This may result from the inclusion criteria of individuals without periodontal disease at baseline and the normal attachment development seen throughout recovery at three and six months in both groups [25]. On the other hand these results are contrary to those

who found no significant difference during the different observational periods which compared to baseline [18].

Respecting the degree of inflammation, the outcomes of the current investigation found that there was a significant change in GI scores by time. It is indicated that there was a significant reduction in GI score after two months followed by a significant increase from two to four months. From four to six months, there was an insignificant alteration in GI scores. GI scores following six months showed significantly lower value compared to baseline score. At base line, after two, four in addition to six months, there was an insignificant variance among both groups.

With respect to plaque accumulation, PI scores in both groups, there was a significant alteration in PI scores by time. It is revealed that there was a significant decrease in PI score after two months. This was followed by a significant increase in PI scores from two to four as well as four to six months. PI scores after six months showed significantly lower value compared to base line score. At base line, following two, four in addition to six months, there was an insignificant variance among both groups.

The outcomes of the GI and PI may be attributed to the completion of soft tissue healing and the case's enhanced capacity to undertake oral hygiene practices comfortably as the soft tissue healed [25, 30].

With regards of pain (VAS) scores in both groups, there was a significant alteration in pain scores by time. It was reported that there was a significant reduction in pain score following one week as well as from one to two weeks. Pain scores after two weeks showed significantly lower value compared to 24 hours' score. After 24 hours, one as well as two weeks, group I illustrated significantly elevated pain score than group II. This might have been attributed to lower operation time in group II than the group I [31].

Regarding the operation time group, I demonstrated significantly extended mean operation time compared to group II. The outcomes obtained may have resulted from the absence of need to manually assess soft tissue and bone levels at each surgical step. This is consistent with the results who found that the operating time decreased significantly by utilizing a surgical guide throughout the insertion of implants, and who reported that the operation time reduces because of the utilization of surgical guides in orthopedic and maxillofacial operation [26, 30, 32].

With respect to patient satisfaction there was significant alteration among patient satisfaction in both groups. The findings of this study were in accordance with those who reported that the cases satisfaction was higher in groups that were operated on utilizing surgical guides throughout the implant insertion [30].

This investigation indicated that the utilization of 3D-printed surgical guides in the management of EGD gave better clinical results in terms of operating time than conventional surgical ECL The findings are agreed with the majority of the literature, since the utilization of surgical guides removes the time needed for manual measurements of soft tissue and bone levels at each step.

Limitations of the investigation included that the sample size was relatively small. So, we recommend that as technology continues to evolve, 3D printing was likely become a more common and reliable tool in crown lengthening procedures, and the integration of digital technologies like CBCT and CAD/CAM was continued to enhance its precision and efficacy. More longitudinal studies are needed to evaluate long-term stability after post-operative ECL. More modified techniques are needed depending on the etiology of EGD.

## Conclusions:

Digitally assisted surgical ECL exhibited superior clinical outcomes over conventional technique on the level of position of post-operative gingival margin and bone level. Digitally assisted surgical ECL appeared to produce less post-operative pain, more acceptance and satisfaction by the patient and shorten the operating time.

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**Conflict of Interest:** Nil

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