Comparison of the flapped and flapless surgical implant procedure on gingival biotype: A prospective split-mouth study

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ABSTRACT

The gingival biotype is critical for implant health and esthetic, masticatory, and hygienic peri-implant soft tissue thickness (STT) results. However, there is no unanimity of data on the effect of gingival biotypes on dental implant survival. Therefore, the current research was aimed at evaluating the outcome of flapped and flapless (FL) surgical interventions on gingival biotypes. The split-mouth study placed forty dental implants in twenty patients (n = 20) in the mandible’s first molar area using flapped and FL implant surgical procedures. Clinical measurements of STT and buccolingual width (BLW) were done at baseline, 3 months, 6 months, and 1 year. Appropriate statistical tests were conducted for intragroup and intergroup comparisons for all the groups with 95% confidence intervals. A p-value less than 0.05 was considered significant. The results revealed a time-dependent increase in the STT in both groups. A significant increase was observed in STT in the flapped group compared to the FL group for 6 months (p = 0.026) and 1 year (p < 0.001). Furthermore, both flapped, and FL groups observed a time-dependent decrease (p < 0.050) in BLW. A significant reduction was observed between the two groups at 6 months (p = 0.040) and 1 year (p = 0.050). The study concluded that between the two groups, the flapped procedure led to a significant increase in STT and a decrease in the BLW of bone. Therefore the FL procedure needs a decrease in the BLW of bone.

INTRODUCTION

In the last few decades, we have seen a drastic change in implant dentistry. The global dental implant market is expected to reach US$13 billion in 2023 [1]. Dental implants have become essential in modern dental practice, with significant advancements such as single-stage flapless (FL) implant placement procedures. These techniques have revolutionized implant placement surgery, improved outcomes, and streamlined treatment approaches [2]. Traditionally, dental implants were placed by elevating the flap for better visualization of the implant site and a better view of anatomical landmarks like the mental foramen, the incisive canal,
Clinicians have been trying hard to determine if the placement of implants by the FL technique influences the longevity of oral implants. The choice between flap and FL is difficult due to a lack of literary evidence. Therefore, the purpose of the present study was to evaluate the impact of the FL implant placement technique compared to traditional flap elevation on gingival biotype, tissue preservation, and overall surgical outcomes.

MATERIALS AND METHODS

Participant selection

The current split-mouth study was conceptualized as a prospective study with forty implants placed by both FL and flap implant surgical techniques. Before this study, a pilot study was conducted with a sample size of five patients, which aimed to recognize the limitations in generalizability and statistical power due to the smaller number size. The earlier study focused on assessing the feasibility of FL dental implants and using it as an exploratory study approach driven by the need to generate hypotheses and gain insights into this novel procedure [7]. This study was carried out after receiving ethical approval from the implant specialty center’s institutional review board at Sewa Charitable Hospital in Udaipur, India (Reference No.: SCHU/IEC/2020/04, Dated August 11, 2020). This study was carried out as per the declaration of Helsinki. Informed consent was obtained from the participants. The primary research was preceded by a pilot where five participants per group were recruited by an independent investigator unaware of the treatment procedure and outcome. Randomization was undertaken by the coin toss method. The sample size calculation using G*Power Version 3.1, keeping the power of study minimum of 80%, was done. Based on the analysis, 20 patients were required to be included per group. Patients were followed at baseline, 3 months, 6 months, and 1 year.

The enrolled patients were aged between 18 and 40 years, with bilateral absence of mandibular first molar. The minimum crestal bone width of 5 mm and local buccal and lingual concavities. It has always helped reduce the risk of bone perforations and penetrating anatomical landmarks [3,4]. However, it had a disadvantage at the time when bones were in limited amounts. The flap elevation often leads to the loss of crestal bone, exposing the implant thread, which influences stress and strain outcomes in the adjacent bone [5]. Flap elevation often tends to tear the flap, leading to flap necrosis due to decreased blood supply, delayed healing, and potential soft tissue scarring.

In recent years, clinicians developed the concept of FL implant surgery to prevent these complications. Patients with sufficient bone volume and gingival tissue that has undergone keratinization have been advised to use this technique [6]. With this method, there is no flap elevation, and the implant is placed straight through the alveolar mucosa. The FL technique’s primary advantage is that it minimizes the risk of postoperative tissue loss [7] and to get relief from soft tissue management after implant placement[8,9]. The other benefit includes less traumatic surgery [10], decreased duration of surgery [2], rapid healing, very few complications, and improved patient acceptance [11]. The FL technique has the advantage of maintaining the blood supply at the bone-periosteum interface, preserving the three-dimensional architecture of both hard and soft tissues surrounding the initial defect. A significant disadvantage of this technique is that the underlying topography of the bone is not visible, leading to an increased risk of perforations (Fig. 1).

The thickness of the gingiva tends to vary across individuals and within the same individual in different parts of the mouth [12]. While a biotype is a unique genetic feature, a phenotype is a complex confluence of genetic and environmental determinants and is site-specific [13]. Implant success depends on many factors but grossly depends on surgical intervention, prosthetic rehabilitation, and hygiene maintenance of dental implants [14]. Numerous research have been conducted to determine the difference between a natural tooth and an implant regarding the gingival biotype [15,16].

![Figure 1. Chart showing the comparison between flapped and flapless implant surgery. This figure has been drawn utilizing the premium version of BioRender with the License number KA256LFY6Y. Image Credit: Susmita Sinha.](image-url)
from bone crest to the top of mandibular canal 10–12 mm or greater, with adequately healed and remodeled ridge with at least 1.5 mm apical-coronal width of attached nonmobile, preferably keratinized soft tissue. The absence of supra-eruption of opposing teeth and periodontal problems in adjacent teeth were included in the study.

Participants with insufficient bone volume, type 4 bone, surgical sites requiring bone augmentation, participants with poor oral hygiene, and smokers were excluded from the study. The study also excluded medically compromised patients suffering from systemic disorders.

**Surgical technique**

Before surgery, all patients were requested to rinse their mouths with 0.2% chlorhexidine. The face of the patient was disinfected with 7.5% povidone-iodine. The oral cavity was prepped with 5% povidone-iodine, and the patient was draped according to conventional surgical guidelines. Local anesthetic with epinephrine (Xylocaine, Astra Zeneca, London, UK) was used to block the regional nerve supply and aid in hemostasis.

To expose the mandibular bone, a full-thickness envelope flap was lifted both buccally and lingually with a no. 9 periosteal elevator, and necessary precautions were taken to avoid damaging the flap. The surgical stent was put on after adequate exposure to the crestal bone (Fig. 2). A crestal mini-incision, approximately 5 mm horizontally with the alveolar crest, was made in the center of the implant site for the FL procedure. The local gingiva was exposed to a depth of around 6 mm, within the range of a big-diameter implant [17–21].

**Procedure for implant placement**

A no. 6 round bur was used to create a pilot hole. The pilot drill was used to prepare the center of the implant site for the initial depth of bone preparation for the implant length. The osteotomy was designed in the prescribed drill sequence (Osstem™, Seoul, South Korea). Following drilling, the crestal heights of the face and lingual plates were evaluated using osteotomy depth and mucosal thickness surrounding the crest. The probe was then gently introduced into the osteotomy walls to determine if the cortical plate had been perforated and if any soft tissue debris remained in the prepared location. The implants were then placed 2 mm below the bone’s crest. Following the installation of the cover screws, the incised wounds were sutured with a single Silk 4-0 suture. Dental implants were manually put in both groups using a wrench, and postoperative radiographs were collected.

**Postoperative care**

The patient has been prescribed an antibiotic regimen of amoxicillin 500 mg thrice daily and an analgesic of 400 mg. Additionally, the patient was instructed to rinse twice daily with 0.2 percent chlorhexidine for 2 weeks and to resume regular brushing 1 week after surgery. The patient was encouraged to practice good dental hygiene during the healing process. Three days after the implantation surgery, patients were examined for a check-up to assess postoperative pain and swelling and to monitor painkiller use. After 7 days, patients were reviewed for a second check-up, during which sutures were removed, and oral hygiene instructions were given. A 1-month and 3-month follow-up was conducted.

**Clinical parametric evaluation**

**Soft tissue thickness (STT)**

A modified caliper was used to record the STT. The examiners were calibrated, so the gingival tissue thickness was directly measured without undue pressure to the gingiva at approximately 2 mm apical to the free gingival margin on the mid-facial aspect. This location was chosen because it is usually still in the keratinized zone, and the measurement is unlikely to be obstructed by the facial bone level. One of the two examiners held the modified caliper during the measurement, and the gingival thickness was recorded to the nearest 0.1 mm. The measurements were made until two duplicate values were registered and recorded. The gingival biotype was considered thin if the measurement was ≤ 1.0 mm and thick if it measured >1.0 mm [22]. This parameter was recorded at baseline, 3 months, 6 months, and 1 year.

**Buccolingual width (BLW)**

Measuring the BLW of the alveolar ridge is critical for presurgical implant placement diagnosis. The precise buccolingual dimension will ensure that the diameter of the implant will not exceed the dimensions of the alveolar bone. The ridge-mapping technique involves a series of measurements with a specially designed caliper. The sharp points of the caliper penetrate the anesthetized mucosa until the surface of the bone is reached. A millimeter scale near the handle end of the caliper will give an accurate reading of ridge thickness.

Ridge mapping necessitates three measurements taken at each implant site: one at the level of the ridge crest, near where the implant’s center and apex would be positioned. This parameter was recorded at baseline, 3 months, 6 months, and 1 year.

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**Figure 2.** Schematic diagram showing the flap implant surgical techniques. This figure has been drawn utilizing the premium version of BioRender with the License number TD5NYVSSI. Image Credit: Susmita Sinha.
Statistical analysis

The present study was conducted by placing forty dental implants in twenty patients \((n = 20)\) in the first molar area of the mandible using both flapped and FL implant surgical procedures prepared. STATA (Version 15) tabulated and statistically analyzed the results. The mean and standard deviation of the data were provided. Repeated measure analysis of variance was conducted for inter-group comparisons at baseline, 3 months, 6 months, and 1 year, with 95% confidence intervals. We also used a multivariate regression model to evaluate the between-group differences. A \(p\)-value was considered significant when it was less than 0.05.

RESULTS

Demography data

The study collected the data of twenty patients from the population, 65% males and 35% females, with a mean age of 32.3 ± 6.04 years (18–40 years).

Quantitative analysis

Soft tissue thickness

The STT showed a time-dependent increase from baseline to 6 months \((p < 0.011)\) and then to 1 year in both FL and flapped groups \((p < 0.002)\) (Fig. 3). The baseline to 3 months \((p < 0.042)\), 6 months \((p < 0.018)\), and 1-year \((p < 0.002)\) comparisons significantly increased in either group (Fig. 1). However, the mean value of STT at 1 year was significantly \((p < 0.001)\) higher in the flapped group than in the FL group (Table 1).

Intergroup comparative analysis

When comparisons were made for STT between FL and flapped groups, it was observed that there was a time-dependent increase in the thickness in both groups. A significant increase was seen in the flapped group compared to the FL group at baseline, 6 months, and 1 year (Fig. 3 and Table 1).

Data were presented as mean ± SD. The multivariate regression model was used to estimate the \(p\)-value. Age and sex were adjusted in the regression model.

Buccolingual width

There was a time-dependent decrease in the BLW of the ridge. The BLW significantly reduced between baseline and 3 months \((p < 0.042)\), with 6 months \((p < 0.001)\), and with one year \((p < 0.001)\) within flapless and flapped groups. However, the reduction was more pronounced in the flapped than in the FL group (Fig. 4).

Data were presented as mean ± SD. A multivariate regression model was used to estimate the \(p\)-value. Age and sex were adjusted in the regression model.

Further, a time-dependent decrease was observed in BLW in both flapped and FL groups. A significant reduction was observed between the two groups at 6 months \((p = 0.040)\) and 1 year \((p = 0.050)\) (Table 2 and Fig. 3). However, intergroup quantitative analysis for baseline and 3 months showed a non-significant \((p > 0.10)\) decrease in BLW.

DISCUSSION

Advances in oral implantology have led to more conservative and less traumatic surgical techniques, particularly in flap design [23]. The mucogingival flap design has revolutionized implant surgery, improving patient comfort, minimizing trauma, and preserving bone loss.

Although flap-based dental implantation provides better visualization during surgery, it has certain drawbacks [2,8,9]. One significant disadvantage is the potential for bone resorption, particularly in poorly vascularized crestal bone. When the soft tissue is elevated, the blood supply to the crestal bone decreases, increasing resorption [2,24–27]. Some studies have suggested that flap elevation can stimulate healing and bone resorption [23,28,29].

On the other hand, the FL technique has gained recognition as a minimally traumatic approach with minimal crestal bone resorption and positive esthetic outcomes. This technique offers several advantages over traditional methods, including reduced complications, pain, swelling, bleeding, surgical time, and preservation of tissues and blood supply. These benefits improve patient satisfaction, comfort, and faster recovery [2].

According to consensus, peri-implant STT is crucial for implant health and aesthetic, masticatory, and hygiene outcomes. Increasing attention is being paid to maintaining gingival thickness around
implants improves the final implant-supported prosthesis. This
is frequently taken to minimize or nullify the influence of the
shades of the abutment (such as titanium alloy, gold, or zirconia)
on the buccal aspect of the mucosa [30–35]. In addition, the
research illustrates how the gingival biotype compensates for any
underlying bone deficits caused by negative osseous remodeling
patterns before or after functional loading.

Although most studies in this area have focused on the
effect of mucosal thickness augmentation for aesthetic purposes,
multiple studies found that performing soft tissue grafting
procedures for mucosal thickness gain resulted in significantly
less interproximal marginal bone loss over time [36,37]. This
study also reiterates the concept of preserving STT. There is no
consensus regarding the minimum acceptable mucosal thickness
needed to minimize marginal bone loss and mucosal recession,
create predictable long-term functional and aesthetic outcomes,
and achieve these objectives. Preserving STT is essential to
achieve optimal functioning and aesthetic outcomes in dental
surgery, especially in cases where implants are used. When
the soft tissue surrounding an implant is thin, there is a higher
risk of marginal bone loss and mucosal recession, leading to
complications such as implant failure or an unattractive smile.
Therefore, preserving STT is critical for the long-term success
of dental implant procedures. However, a significant number of
scientific researches on this topic found that the mucosal effect
of the abutment shadow was reduced in areas with a minimum
mucosal thickness of around 2 mm [22,30,36].

The present study showed a time-dependent increase
in the thickness of the soft tissue in both groups, but the
consistency was more prominent in the flapped group. This
finding indicates the undergoing healing process and could
imply that using a flap during the surgical procedure may have
provided some additional benefits to the healing process. This
result aligns with the findings of several other studies [24,25,38].
This increase in thickness in flapped surgery can be attributed
to the laceration caused by the underlying mucoperiosteal flap.
Once the laceration occurs, the polymorphonuclear neutrophils
and macrophages rush to the damaged site. Fibroblasts and
fibroblast-like cells are the most predominant reparative
cells that migrate to the surgical site. Fibroblast migration in
the extracellular matrix depends on precise recognition and
interaction with specific components of the matrix. Collagen
synthesis takes place, which leads to the formation of granulation
tissue. As time passes by, these granulation tissues mature and
form fibrous tissue. This hyperinflammatory reaction is thought
to be the reason for the increased STT in flapped surgery [39].

The mucosal thickness also depends on the BLW or
peri-implant bone thickness, which is the horizontal dimension
of the anatomical bone. Not just the soft tissue over the bone but
the underlying bone is a vital parameter for correctly evaluating
surgical, esthetic, and prosthetic outcomes. Coronal bone
remodeling consisted entirely of a buccolingual constriction of
the crestal ridge. New bone apposition to fill the peri-implant defect
and buccal and lingual bone resorption could be responsible for
the pattern of bone rearrangement. This remodeling decreased
the width of the alveolar ridge and existed around all examined
implants. However, the delayed implants had smaller buccolingual
bone widths when the initial measurements were recorded [40].
There has been sparse literature evidence in which the dimension
of the buccolingual aspect of the bone pre- and post-implant has
been evaluated. There are some studies indicating the changes in
the buccolingual dimension of bone following the extraction of a
tooth. The subsequent healing of the socket and the bone growth
within the tooth socket would eventually become synchronized
with the resorption of the alveolar ridge. The buccal side would
show more obvious bone loss in horizontal and vertical directions,
making the ridge shorter and narrower [21,40]. Multiple studies
suggested that socket remodeling had a more enormous impact
in the horizontal direction than in the vertical [30,41,42]. In their
investigation, extraction sockets lost significantly more breadth
than height during the healing process. Consistent with earlier
studies, the current data support that the essential components
necessary to induce bone healing are primary implant stability,
bony walls capable of sustaining a solid blood clot, and primary
flap closure [43]. This study also stated a time-dependent decrease
in the BLW of the ridge in both groups. The 6-month intergroup
comparison showed a significant reduction, whereas it was less
critical at the end of a year. This suggests that there was some
level of bone resorption or loss occurring in both groups over
time. The difference between the groups became less significant
at the end of a year, which may indicate some natural bone
remodeling or regeneration occurring over time.

| Table 2. Intergroup evaluation of BLW for FL (Group 1) and flapped
groups (Group 2). |
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<tr>
<td></td>
<td>FL</td>
<td>Flapped</td>
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<tr>
<td>Baseline</td>
<td>11.6 ± 1.42</td>
<td>12.1 ± 0.72</td>
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<tr>
<td>Month 3</td>
<td>11.4 ± 1.39</td>
<td>11.4 ± 0.71</td>
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<tr>
<td>Month 6</td>
<td>11.0 ± 1.30</td>
<td>10.30 ± 0.66</td>
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<tr>
<td>Year 1</td>
<td>9.30 ± 1.13</td>
<td>8.70 ± 0.66</td>
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Figure 4. Quantitative evaluation of BLW between FL and flapped
group (n = 20).
Another study suggested criteria to evaluate the success of implants. As per this criterion, an annual bone loss should be less than 0.2 mm after the implant becomes functional. This criterion is necessary for long-term implant success [44,45]. Since the crestal bone present has become the primary criterion for evaluating implants’ success, it has become essential to save every bit of it. Nevertheless, the buccolingual dimension of the bone is paramount; hence, any changes recorded after the placement of implants will give clinicians logical prognostic attributes. This parametric evaluation of the BLW in the initial years of implants has shown a positive correlation between flap elevation and gingival recession. Hence, moving to the FL technique was needed to preserve crestal bone.

CONCLUSION

In conclusion, the evolution of oral implantology has brought about advancements in flap design and surgical techniques to improve patient comfort, reduce trauma, and preserve bone loss. Although it provides better surgical field visualization, the mucogingival flap technique has disadvantages, such as bone resorption due to the poorly vascularized crestal bone. On the other hand, the FL technique has emerged as a minimal traumatic approach, resulting in reduced bone resorption and improved esthetic outcomes.

Preserving STT around implants has been recognized as crucial for implant health and aesthetic outcomes. Studies have shown that increasing or maintaining gingival thickness can minimize the influence of abutment shadows on the buccal aspect of the mucosa and reduce interproximal marginal bone loss. The FL technique has been found to contribute to the increase in STT during the healing process, possibly due to the hyperinflammatory reaction and granulation tissue formation.

Furthermore, evaluating the buccolingual dimension of the bone is essential for assessing surgical, esthetic, and prosthetic outcomes. Changes in the BLW of the ridge over time have been observed, emphasizing the need for bone preservation techniques. The long-term success of dental implant procedures relies on preserving crestal bone, as indicated by the implant success criteria, including minimal annual bone loss.

Overall, advancements in flap design, soft tissue preservation, and bone maintenance techniques have significantly improved dental implant procedures’ functional and esthetic outcomes.

AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the International Committee of Medical Journal Editors (ICMJE) requirements/guidelines.

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CONFLICTS OF INTEREST

The authors report no financial or any other conflicts of interest in this work.

ETHICAL APPROVALS

This study was carried out after receiving ethical approval from the implant specialty center’s institutional review board at Sewa Charitable Hospital in Udaipur, India (Reference No.: SCHU/IEC/2020/04, dated August 11, 2020).

DATA AVAILABILITY

All data generated and analyzed are included in this research article.

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REFERENCES


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