

Minimally invasive transgingival implant therapy: A literature review

ABSTRACT

Transgingival (flapless) implant placement procedure is a minimally invasive surgical technique in which implant is placed without reflecting mucoperiosteal flap and hence the blood supply of bone is not hampered which is advantageous in many ways. To compare the outcomes of various implant placement techniques, an electronic database of various journals from January 1990 to March 2017 were analyzed and only human clinical trials with 6 months follow-up and at least five implants in each group were reviewed. The present literature review focuses on the comparative aspects of flapped versus flapless implants in terms of their survival, marginal bone loss, soft-tissue parameters, and patient-centered outcomes. When the proper protocol is followed by experienced surgeons, no significant difference was observed in survival rate, marginal bone loss, and keratinized mucosal width between flapless and conventional flap technique. Although transgingival approach for implant placement is reported to significantly reduce the surgical time, increased patient comfort and acceptance, i.e. the patient centered outcomes such as postoperative pain, swelling, and visual analog score, are minimized. Hence, it is concluded that transgingival (flapless) implant placement technique is well accepted by the patient with potential outcomes as compared to the conventional implant placement approach.

Keywords: Dental implants, flapless, flapped, implant surgery, outcomes, review

INTRODUCTION

The conventional approach to dental implant (DI) surgery involves crestal incision and reflection of mucoperiosteal flap to visualize and access underlying alveolar bone which ensures the identification and protection of underlying anatomical landmarks such as foramina, lingual undercuts, and maxillary sinuses. In case of limited alveolar bone, flap reflection will facilitate implant placement by optimizing implant positioning and minimizing the risk of bone fenestrations. In the recent era, the techniques that provide function, esthetics, and comfort with a minimally invasive surgical approach are well accepted among clinicians as well as patients. To fulfil this requirement, transgingival (flapless) implant surgery has been advocated by many clinicians. This approach can be used to simplify the procedure of implant placement.^[1]

Flapless implant surgery is defined as a surgical procedure used to prepare the implant osteotomy and to place the implant without elevation of a mucoperiosteal flap.^[2] In

this approach, the amount of remaining alveolar bone is thoroughly evaluated, and sometimes, implant position is predetermined from three-dimensional radiography as well as surgical guides which are used to guide and place the implant in the optimal position based on the presurgical treatment planning. This approach is reported to significantly reduce the surgical time, postoperative bleeding, patient discomfort, and increase patient acceptance.^[3] It also helps in the preservation of vascularity, soft-tissue architecture, hard

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tissue volume, and accelerated recuperation, allowing the patient to resume normal oral hygiene measures immediately after the procedure.^[1]

In the case of immediate implant placement in fresh extraction socket, flapless implant placement is preferred to preserve vascular supply and existing soft-tissue contours, which optimize the healing of peri-implant tissues.^[4,5]

The circular incision or punch used for removing overlying soft tissue is usually 1 mm wider than the diameter of the implant to be placed, which minimize the postoperative pain, soft-tissue swelling and discomfort related to soft-tissue trauma.^[6] It is advisable to use a bone caliper to measure the buccolingual dimensions of the bone at approximately three different points: the top of the ridge, near the center and apex of the predicted implant site. These measurements reveal the presence of any undercuts in the bone. If an undercut of more than 15° is detected, traditional flap reflection is recommended, to allow for greater visibility when placing the implant. If no significant undercut exists, the tissue punch is employed, and a curette is used to remove the plug of soft tissue, exposing the bone. A number 3 round bur is used to penetrate the cortical bone, followed by a pilot drill. The implant is then inserted in the standard manner.^[7]

As transgingival implant surgery is considered a blind surgical procedure, certain surgical risks, and complications may occur. The vital structures are present near vicinity of osteotomy sites, and as the flapless surgical procedure is a masked approach, chances of damage to vital structures are increased. The damage to the nerves and neighboring teeth can be avoided by computer-guided navigation.^[8]

Another complication is the placement of the implant apical to the alveolar bone crest which causes difficulty in placement of abutment. Therefore, the relationship between the implant and abutment connection should be verified by periapical radiographs. If bone prevents abutment seating, the implant should be backed out until it is at the crest or the bone should be removed with a profile drill.^[9] As transgingival implant surgery is considered a blind surgical procedure, certain complications such as unrecognized bony dehiscence/fenestration can occur. In such cases, full flap reflection is required, and Guided Bone Regeneration procedures should be performed to augment the bone and cover the fenestration.^[9] Flapless surgery results in the loss of keratinized tissue (KT) which is removed during implant placement.^[9] Another disadvantage of flapless technique is that underlying osseous topography cannot be contoured when required. Flap elevation is necessary in these cases.^[9]

Being a technique sensitive procedure, the survival rate (SR) might be adversely affected. The purpose of this article is to review the literature comparing various parameters such as SR, marginal bone loss, keratinized mucosal width, and esthetic outcomes, in conventional flapped and flapless procedure.

TECHNIQUES FOR FLAPLESS IMPLANT PLACEMENT

The main categories of surgical approach can be divided into:

1. Conventional implant placement without the use of a surgical guide (free-hand)
2. Guided surgery using conventional backward planning without three-dimensional (3D) navigation and
3. Guided surgery using 3D navigation techniques (3D implant planning software).

Conventional implant placement without the use of a surgical guide (free-hand)

Soft-tissue punch

Implant placement can be done either by tissue punch at the center of the drilling site, or transgingivally with a round bur to penetrate the soft tissue directly into the bone without raising the flap. The integrity of the interdental papilla and the alveolar blood supply of the surrounding osseous tissue is not disrupted due to intact overlying mucoperiosteum. The drawback of this technique includes the inability to submerge implants that are not adequately stabilized.^[10]

Flapless implant procedure using a mini-incision

A crestal mini-incision of approximately 5 mm is made to the alveolar crest at the center of the implant site followed by the local undermining of the gingiva. The amount of undermining of the implant site should not exceed 5 mm and the soft tissue on both sides of the incision line is pushed aside to accommodate the drills and implants.^[10]

Guided Surgery using conventional backward planning without three-dimensional navigation

After taking intraoral maxillary and mandibular impressions, fabrication of surgical template by transformation in dental laboratory is done.

Guided surgery using three-dimensional navigation techniques (three-dimensional implant planning software)

The introduction of cone-beam computed tomography, 3D implant planning software, image-guided template production techniques, and computer-aided surgery are important achievements in optimizing 3D implant positioning. After the preoperative evaluation of the implant site, the transfer of planning and insertion of implants can be accomplished through a surgical guide or computer-assisted navigation in a predetermined exact position.^[11-14]

It is recommended that flapless implant placement should be used with computer-aided design- computer-aided engineering (CAD-CAM) technique, but there are several studies which have demonstrated that with good clinical expertise they can be conducted without CAD-CAM also.

De Bruyn *et al.* concluded that free-handed flapless surgery is a viable alternative to more extensively planned guided surgery. Proper case selection and clinical experience are considered prerequisites for a predictable treatment outcome.^[15] Cannizzaro *et al.* used the flapless surgical technique without guided navigation and found SR of 97% for flapless group versus 97.4% SR for conventional flap group.^[16]

METHODS USED FOR LOCATING, SELECTING, EXTRACTING, AND SYNTHESIZING DATA

A search of five electronic databases, including PubMed, Ovid (MEDLINE), EMBASE, Web of Science, and Cochrane Central, for relevant studies published in the English language from January 1990 until March 2017 was performed. The search terms used, in which mh represented the MeSH terms and tiab represented title and/or abstract, included the following: (“dental implants”[mh] OR “dental implantation”[mh] OR (“implant”[tiab] OR “implants”[tiab]) AND (dental [tiab] OR oral [tiab] OR tooth [tiab])) AND (“surgical flaps”[mh] OR “flap”[tiab] OR “flapless”[tiab] OR “flapped”[tiab]). Human clinical trials involving a minimum of five implants in each technique and with a follow-up of at least 6 months after implant placement were included.

COMPARISON OF VARIOUS OUTCOMES: CONVENTIONAL FLAP VERSUS FLAPLESS TECHNIQUES: EFFECT OF FLAPLESS IMPLANT ON IMPLANT SURVIVAL RATE

The success of flapless implant surgery depends on the precision and experience of implant surgeon as there is a learning curve which affects the success rate of flapless implants. In addition to these, surgeons must have knowledge of indications and techniques used for management as well as augmentation of peri-implant tissues. Hence, when the technique was relatively new, the success rate of flapless implant placement was relatively low and increased considerably, from 74.1% in 1990 to 100% in 2000.^[6] In a 2 year study by Becker *et al.*, 98.7% success rate at 2 year follow-up was found with the flapless approach.^[17] Similarly, al-Ansari *et al.* (1998), noted 100% success rate with the flapless approach in 20 implants.^[18] Rousseau, in a randomized controlled trial, found the success rate of 98.3% (171/174) with flapless technique while 98.5% (200/203) with traditional flap technique.^[19] Similarly, Van de Velde *et al.*, reported SR

of 97.3% with flapless method compared to flap technique in which 100% SR was seen in a randomized trial.^[20] Meta-analysis for the comparison of SR presented an overall risk ratio of 0.99 (95% confidence interval = 0.97–1.01), which was statistically insignificant ($P = 0.30$). DIs placed with flapless and flap techniques achieved high SR i.e., 97.0% (ranged from 90% to 100%) and 98.6% (ranged from 91.67% to 100%), respectively, with a mean follow-up period of 16.1 months which indicates that implant placement without raising a flap is as predictable as the conventional flap approach. Nevertheless, factors such as strict selection criteria and experienced surgeons performing procedure should be considered while interpreting results in the comprehended studies.

On the other hand, Chrcanovic *et al.*, in their meta-analysis concluded that the insertion of implants by the flapless surgery increases the risk of implant failure by Risk Ratio of 1.75.^[21]

FLAPLESS IMPLANT AND MARGINAL BONE LOSS

Achieving an esthetic end result is a major determinant of success in the anterior esthetic zone. Interproximal crestal bone loss of <0.2 mm annually is a criterion for implant success.^[22] The crestal bone area is considered to be a significant indicator of implant health, as this area bears the maximum stress around an implant.^[23] Blood supply to the crestal bone area is reduced around an implant compared with that of a natural tooth because the blood vessels from the periodontal ligament are absent and its major source of blood supply is from the periosteum covering the bone. It should also be considered that in the conventional flap technique, after raising a mucoperiosteal flap the remaining blood supply of that area is hampered and chances of postoperative marginal bone loss increases, compared to minimally invasive flapless surgery where the periosteal blood supply of bone is not disrupted.

In a randomized control trial by Sunitha and Sapthagiri with 40 patients, no statistically significant difference was found between two groups. The mean difference in bone loss for 0–6-month, 6-month to 1-year, and 1-to 2-year time period in flapless group was 0.03 ± 0.01 , 0.07 ± 0.01 , and 0.09 ± 0.02 , respectively, while in conventional flap group, it was found to be 0.17 ± 0.06 , 0.35 ± 0.25 , and 0.47 ± 0.40 , respectively, indicating greater bone loss in flap group of implant placement.^[24] In another randomized trial by Cannizzaro *et al.*, no statistically significant difference between marginal bone loss was reported in two groups, where 76 implants were placed through flapless method and 67 after flap elevation.^[25]

The marginal bone resorption was not found to be statistically significant in a study with conventional flap versus CT-guided flapless surgery by Ozan *et al.*^[26] In another study, flapless implant placement technique proved to be beneficial in preventing marginal bone loss at 3 months follow-up, but in long-term follow-up, no statistically significant marginal bone loss was found.^[20]

A meta-analysis performed by Lin *et al.* (2014), reported no significant difference between two procedures for marginal bone loss. This revealed that the flapless procedure might not influence bone remodeling, examined at the macroscopic scale. On the contrary, two clinical trials, with short-term follow-up (3- and 4-month follow-up, respectively) reported a significant reduction of marginal bone resorption with the flapless approach.^[27,28] Hence, it is possible that the flapless procedure might have a beneficial effect on maintaining the bone level at the early stage of healing. As the healing proceeds, the bone reparative mechanism catches up in the flap procedure; eventually, no difference in marginal bone height can be observed. In addition, other studies opposed the concept of flapless surgery as it did not allow direct visualization of the alveolar ridge and therefore, the implant could not be positioned as accurately as in the flap approach, which resulted in more bone loss. Besides that, to remove adequate bone for placement of the healing abutment, a countersinking procedure might be overdone in the flapless surgery, which could lead to a more marginal bone loss.^[29]

However, it was found in some studies that the flapless technique generated more marginal bone loss around the implants.

De Bruyn *et al.*, suggested that the probable cause of marginal bone loss in their study was overdoing of the countersinking procedure, because more extensive widening of the crestal bone was necessary to remove sufficient amount of bone to allow proper placement of the healing abutment. By countersinking wider and deeper, the coronal portion of the implant is not always in intimate contact with the bone. In the conventional approach, the countersinking procedure was more controlled according to the guidelines of the manufacturer because visual inspection *in situ* was possible.^[15]

Rousseau elaborated that this is due to implants being installed blindly, and thus implants are installed more deeply with the flapless technique than with the open flap technique. Therefore, a portion of the transmucosal (supracrestal) part of the implant is slightly below the crestal bone level and as the coronal part of the implant is smooth titanium, rearrangement of bone around the neck of the implant is normal. While in

an open flap technique the implant is installed under visual control at the right crestal bone position which results in less bone rearrangement around the implant neck.^[19]

FLAPLESS IMPLANTS AND KERATINIZED GINGIVA

It is considered that during flapless placement of implants, we need to remove gingival tissue, which may lead to more loss of keratinized gingiva postoperatively. However, a randomized trial by Oh *et al.*, suggested that no statistically significant difference found in width of keratinized gingiva between flapped versus flapless group in 6 months follow-up.^[30] A similar result was reported by Bashutski *et al.* in their randomized clinical trial.^[31]

Although controversies regarding necessity of KTs for maintaining health around DIs exist in the literature but based on the results of the studies performed, wide KT band has an important role in formation of a resistant barrier against mechanical trauma during oral hygiene procedures especially in patients with severe bone and soft-tissue atrophies and helps in formation of peri-implant tissues in which nonkeratinized epithelium may become ineffective. Further, it has been observed that adequate KT width (KTW) prevents tissue prolapse during the intervals between prosthetic procedures by preserving the junctional epithelium during functional movements of the mucosa, precludes mucogingival stress, which aids in the maintenance of peri-implant tissue health.^[32,33]

FLAPLESS IMPLANTS AND PATIENT-CENTERED OUTCOMES

It is believed that flapless implant surgery is more beneficial in the context of patient-based outcomes, as it is a minimally invasive procedure with the small operative field, less operative time, minimal manipulation of surrounding tissue and least hampering of blood supply of underlying bone. Further, there is no need for reflection of mucoperiosteum and suturing after the surgical procedure. Insertion of flapless DIs prevents complications arising from soft-tissue elevation such as infection, dehiscence, and necrosis, and provides DI success rates equal to that of the conventional technique.^[17] Some studies even suggest that with flapless implant surgery, patients' postoperative discomfort such as swelling and pain is almost negligible.^[29] Another study by Fortin *et al.*, on flapless implant outcome using parameters such as visual analog scale for pain and analgesics taken by patient postoperatively to relieve pain, concluded that with the flapless procedure, patients experienced less intense pain and for shorter duration.^[34] In contrast to these studies Lindeboom and van Wijk, in their randomized controlled trial of 96 implants, found no differences between conditions

on dental anxiety (s-DAI), emotional impact (IES-R), anxiety, procedure duration or technical difficulty. The flap procedure group displayed less impact on quality of life and reported more patients with no pain at all during placement.^[35]

Lee *et al.* in their randomized controlled trial evaluated soft tissue change around implant at 1 week, 1 month and 4 months. Soft-tissue profiles assessed 4 months after flapless implant placement were similar to profiles assessed immediately before implant placement. Hence, they concluded that flapless implant surgery is advantageous for preserving mucosal form, surrounding DIs.^[36]

FLAPLESS IMPLANT SURGERY AND IMMEDIATE IMPLANT PLACEMENT

Immediate DI placement can be used in specific conditions. For the patient, the advantages are: Reduced number of surgical procedures, no need for a provisional prosthesis supported by other teeth, preservation of alveolar ridge, and maintenance of the gingival margin with minimal esthetic damage. A careful flapless extraction that preserves the alveolar walls and minimizes gingival trauma followed by implant placement associated with a provisional crown (with or without loading) has been shown to improve the esthetic result.

Bashutski *et al.* revealed greater papillary fill in case of flapless immediate implant placement compared to conventional immediate implant placement at 6 and 9 months, but the results were not comparable at 15 months.^[31] Another study revealed greater mid-buccal recession, but no difference in interproximal recession at 12-month follow-up between two groups.^[37]

Although the flapless technique has a tendency of achieving greater papillary index, indicating that more papillary fill might happen after the flapless procedure, the meta-analysis by Lin and coworkers did not find any statistically significant difference, and the loss of keratinized mucosa also led to the unsatisfactory esthetic outcome.^[29]

From above-mentioned studies, conflicting results were reported in implant placement using flapless techniques. Hence whether to use the flapless technique in these situations depends on patient comfort, accessibility, need for ridge augmentation, and clinicians skill.

CONCLUSION

Although the flapless technique is proved to be more beneficial when combined with CAD-CAM technique, but

due to its cost sensitivity and complexity, the other methods of placing flapless implants, i.e., guided surgery without 3D navigation and flapless technique without a surgical guide, should be considered but only by skilled clinicians with high clinical expertise. With the flapless approach, implant SR, marginal bone loss, KTW, and esthetic outcomes commensurate with conventional flap approach on long-term follow-up but patient-centered benefits, mainly reduced surgical time, increased comfort, and acceptance cannot be overlooked.

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Conflicts of interest

There are no conflicts of interest.

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