Dental implant placement with flapless and flapped technique: A systematic review.

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Abstract: Aim: This study was aimed to systematically review and compare implant treatment outcome including success and survival rates, marginal bone loss and post-operative pain between flapped and flapless techniques of implant insertion. Material and Methods: An internet search was performed in PubMed and Cochrane Library in June 2018 using relevant keywords limited to human studies and English language. Clinical studies evaluating the survival rate, marginal bone loss (MBL) and rate of complications between flapped and flapless techniques for implant insertion were included. The review process was performed by two reviewers and the relevant data was extracted from the included studies. Data was compared in a qualitative manner. Results: Electronic search resulted in 1872 studies out of which 32 (21 RCTs) were selected based on the inclusion and exclusion criteria including 1528 patients and 3047 implants. No significant difference was found between success and survival rate of implants using two techniques except for one study that reported higher success rate in flapless group. Twelve studies reported higher MBL in the flapped groups while two studies showed higher MBL in the flapless group. Less pain following flapless technique was reported in 9 studies. One study, however, showed more pain in flapless technique. Conclusion: Implant survival rate using flapped and flapless technique is comparable. Also, MBL using flapless technique is similar or less than flapped technique. Concerning post-operative complications, flapless technique would probably have less post-operative pain.

Keywords: dental implants; surgical flaps; survival rate; postoperative complications.

INTRODUCTION.

Following tooth loss, which is associated with aesthetic and functional problems, dental implants can be placed. Although high success rate have been reported for dental implants1 with little alveolar bone loss,2,3 marginal bone loss is still a common complication that could happen for various reasons.4,5 Following marginal bone loss, implants may fail and further treatment such as complicated reconstructive6,7 or regenerative procedures8,9 may be needed. Several techniques have been employed to prevent alveolar bone loss and increase dental implant success rate. These attempts include implant surface modification (acid etch, sandblast and hydroxyapatite coating),10 implant geometry alteration (conical and cylindrical fixtures)11 and changes in implant threads (type, shape and depth of threads).2,12 In addition, several
modifications have been performed to reduce marginal bone loss following implant insertion.

On the one hand, conventional implant placement technique involves full thickness flap prior to implant insertion. This approach allows the clinician to directly visualize the alveolar bone and assess bone morphology of the ridge. Also, using this technique, crestal ridge morphology alteration and augmentation could be performed. The current guidelines indicate this technique in case of lack of sufficient attached gingiva and a need of simultaneous recipient site augmentation. However, this technique is relatively invasive and causes patient discomfort and marginal bone loss. When flap is reflected, catabolic activities shifts and osteoclastic activity and bone loss increase.

On the other hand, flapless implant insertion technique involves punching of the soft tissue without flap reflection. Reduced surgery time and less patient discomfort has been reported using this technique. Although clinicians assume that using flapless technique results in less marginal bone loss due to the less invasive approach, the proposed disadvantage of this technique is reduced implant survival rate. This approach is generally indicated for specific patients such as those who demand esthetic treatments, implants placed in esthetic areas, fractured teeth, endodontic failures, non-restorable caries, and radicular caries. In these cases, the periodontal tissue should be healthy prior to implant placement. Soft tissue dehiscence and fenestrations are considered as contraindication for flapless implant insertion.

Implant treatment outcomes by flapless approach have been reviewed previously. A review of 13 studies revealed that flapless technique results in 97.2% survival rate of dental implants and a mean 1.45mm marginal bone loss during 1-4 years of follow up. Another review also showed that using flapless technique the implant survival rate was 98.6% with 3.8% complication rate. Flapless technique had 97.1% and 6.55% survival and complication rates respectively, for implants placed in the maxillary posterior region.

Comparison of implant treatment outcome and complications between flapped and flapless groups has been performed by some clinical studies, and systematic reviews. In a clinical situation, clinicians should be able to predict the possible outcome of each treatment and systematic reviews are necessary for such evidence-based clinical decision making.

The main purpose of this study was to systematically review published randomized clinical trials (RCT) and prospective studies comparing implant survival rate, alveolar bone loss and post-operative pain between flapless and flapped implant insertion techniques and to update previous reviews.

**MATERIALS AND METHODS**

**Study design**

This study was performed in compliance with the PRISMA statement. In this current review, clinical studies evaluating the survival rate, alveolar bone loss and rate of complications between flapped and flapless techniques for implant insertion were included. Only RCTs and prospective studies were included. Use of flapless technique was necessary for inclusion. Also, the minimum number of patients for inclusion was 10 implants and only studies that used fixed partial dentures were included. Animal studies, case reports, case series, retrospective studies and review articles were excluded. Also, studies on patients with systemic diseases, fresh socket implant placement, studies with removable prosthesis and studies using short implants (less than 8mm length) were excluded.

**Electronic search and study selection**

An electronic search was performed using PubMed and Cochrane Library up to June 16th 2018 limited to English language and human studies. A combination of relevant keywords was used according to PICO (Table 1). Initial screening of titles and abstracts was carried out and full texts of the potentially eligible studies were obtained for further evaluation. Studies were included based on established inclusion/exclusion criteria by two reviewers separately. Disagreements were discussed with the third reviewer.

**Data extraction**

Relevant data including study methodology, number of patients, number of implants and mean length and diameter, mean age, and surgical procedure data including flapped or flapless technique, brand and type of implants,
implant insertion site, and loading protocol as well as implant therapy outcome including follow up duration, success, failure and survival rates, marginal bone loss and post-operative pain were extracted from each study. Outcome of the longest follow up was extracted.

Data analysis
Included studies were evaluated in a qualitative manner and no statistical and meta-analyses were performed. Assessed outcomes were implant survival and success rate, alveolar bone loss, pain, and other complications.

RESULTS.
Search process
Study design is illustrated in figure 1. Initial search resulted in 1872 studies which was reduced to 249 studies in the PubMed database and 38 in Cochrane Library after limiting the results to human and English language studies. All the titles found in the Cochrane Library were duplicate of those found in the PubMed database. Therefore, a total number of 249 articles were screened. The screening step through reviewing titles and abstracts was then performed, yielding 47 studies. Finally, 32 studies\(^\text{23-35,40-59}\) were included after meticulous assessment of the full-texts based on inclusion and exclusion criteria.

Table 2 demonstrated summary of the included studies regarding methodology and demographic data.

Study design
Among the 32 included studies, 21 studies\(^\text{26,30,31,33-35,40,42-46,48,51,53-58}\) were RCT while the others were non randomized prospective clinical trials (Table 2).

Total number of patients
A total number of 1528 patients were evaluated in the included studies. Among them, 616 and 912 were in RCTs and prospective studies, respectively.

Figure 1. Flow-diagram.

Records identified through PubMed database searching
(n = 1872)
Records identified through Cochrane Library searching
(n = 38)

Records after filtration of the search results and removal of duplicates
(n = 249)

Records screened (n = 249)
Records excluded (n = 202)

Full-text articles assessed for eligibility
(n = 47)
Full-text articles excluded
(n = 15)

Studies included in qualitative synthesis
(n = 32)
Table 1. Relevant keywords used for electronic search.

| PICO       | MeSH                                      | Phrases                        |
|------------|-------------------------------------------|--------------------------------|
| Population | “Dental Implants”, “Jaw, Edentulous”     | implant*                       |
| Intervention| “Minimally Invasive Surgical Procedures” | flapless, incisionless         |
| Control    | “Surgical Flaps”                          | “full-thickness flap”, “flapped, “open flap”, “conventional flap” |
| Outcome    | “Survival Rate”, “Infection”, “Operative Time”, “Pain”, “Pain Measurement” | complication*, “success rate”, failure, “crestal bone loss”, “marginal bone loss”, “bone loss”, “bone resorption”, “keratinized mucosa”, “attached mucosa”, “keratinized gingiva”, “attached gingiva”, “probing depth”, “pocket depth”, “papillary index” |

Table 2. Summary of the included studies regarding methodology and demographic data.

| Author           | Year | Type of Study | No. Patients (Total) | Age range (year) | Female |
|------------------|------|---------------|----------------------|------------------|--------|
| Sunitha et al.   | 2008 | Prospective   | 10                   | NA               | NA     |
| Becker et al.    | 2005 | Prospective   | 57                   | 24-86            | 33     |
| Job et al.       | 2008 | Prospective   | 6                    | 35-55            | NA     |
| Tsoukaki et al.  | 2013 | RCT           | 20                   | 30-62            | 11     |
| Jeong et al.     | 2011 | Prospective   | 241                  | 19-73            | 133    |
| Jeong et al.     | 2008 | Prospective   | 129                  | 19-73            | 71     |
| Becker et al.    | 2009 | Prospective   | 57                   | 24-86            | 33     |
| Ozan et al.      | 2007 | RCT           | 12                   | 42-51            | 7      |
| Al-Juboori et al.| 2012 | RCT           | 9                    | 27-62            | 6      |
| Van de Velde et al. | 2010 | RCT           | 14                   | 39-75            | 9      |
| Cannizzaro et al.| 2011 | RCT           | 40                   | 22-65            | NA     |
| Fortin et al.    | 2006 | RCT           | 60                   | 19-82            | 38     |
| Cannizzaro et al.| 2008 | RCT           | 40                   | 18-64            | 10     |
| Oh et al.        | 2006 | RCT           | 57                   | 31-61            | 14     |
| Nikzad et al.    | 2010 | Prospective   | 16                   | 42-66            | 7      |
| Lindeboom et al. | 2010 | RCT           | 16                   | 51-65            | 13     |
| Berdougo et al.  | 2010 | -             | 169                  | 20-48            | 111    |
| Froum et al.     | 2011 | RCT           | 60                   | NA               | 35     |
| Parmigiani-Izquierdo et al. | 2013 | RCT           | 19                   | 41-59            | 4      |
| Sunitha et al.   | 2013 | RCT           | 40                   | 25-62            | 15     |
| Bashutski et al. | 2013 | RCT           | 24                   | 22-78            | 14     |
| Meizi et al.     | 2014 | Prospective   | 155                  | 47.5             | NA     |
| Pozzi et al.     | 2014 | RCT           | 51                   | 28-84            | 24     |
| Malo et al.      | 2016 | Prospective   | 41                   | 19-79            | 22     |
| Maier et al.     | 2016 | Prospective   | 80                   | 18-78            | 50     |
| Pisoni et al.    | 2016 | RCT           | 40                   | 61.69            | 9      |
| Prati et al.     | 2016 | Prospective   | 60                   | 25-72            | 26     |
| Wang et al.      | 2017 | RCT           | 40                   | 19-45            | 14     |

RCT: Randomized controlled trial. NA: Not available.
| Authors          | Surgical technique | Computer guided | No. | Implant Length (mm) | Diameter (mm) | System                  | Site | Mx | Mn | Loading protocol |
|------------------|--------------------|-----------------|-----|---------------------|---------------|-------------------------|------|----|----|------------------|
| Becker et al., 24| Flapless           | No              | 79  | 8.5-13              | 3.75-5.0      | Nobel Biocare           | 32   | 47 |    | Con              |
| Fortin et al., 34| Flap               | No              | 72  | NA                 | NA            | NA                      | NA   | NA | NA | NA               |
|                  | Flapless           | Yes             | 80  |                     |               |                         |      |    |    |                  |
| Oh et al., 40     | flapless           | No              | 12  | 10.0-13.0           | 3.7-4.7       | Zimmer                  | 24   | 0  |    | Imm              |
| Ozan et al., 30   | Flap               | Yes             | 45  | 8.0-12              | 3.7-4.8       | Swissplus Zimmer        | 34   | 25 |    | Con              |
|                  | Flapless           | Yes             | 14  |                     |               |                         |      |    |    |                  |
| Job et al., 25    | Flap               | No              | 5   | 10.0-15.0           | 3.8           | Single piece root form  | NA   | NA | Imm|                  |
|                  | Flapless           | No              | 5   |                     |               |                         |      |    | Imm|                  |
| Jeong et al., 28  | Flap               | No              | 142 | NA                 | NA            | Astra                   | 99   | 187|    | Con              |
|                  | Flapless           | No              | 144 |                     |               |                         |      |    |    |                  |
| Cannizzaro et al.,35| Flap              | Yes             | 56  | 10.0-14.0           | 3.7-4.8       | Swissplus Zimmer        | 49   | 59 |    | con              |
|                  | Flapless           | Yes             | 52  |                     |               |                         |      |    |    | Imm              |
| Sunitha et al., 23| Flap               | No              | 10  | NA                 | 3.7-4.8       | Swiss plus              | NA   | NA |    | Con              |
| Becker et al., 26 | Flapless           | No              | 79  | NA                 | NA            | Nobel Biocare           | NA   | NA |    | Con              |
| Nikzad et al., 44 | Flapless           | Yes             | 57  | 8.0-15.0           | 3.3-4.8       | Zimmer, ITI, Astra, easy implant | 0    | 57 |    | Co               |
| Van de Velde et al.,32| Flap         | Yes             | 34  | 8.0-12              | 4.1-4.8       | ITI                     | 70   | 0  |    | Con              |
|                  | Flapless           | Yes             | 36  |                     |               |                         |      |    |    | Imm              |
| Lindeboom et al.,42| Flap              | Yes             | 48  | NA                 | NA            | Nobel replace           | 96   | 0  |    | NA               |
|                  | Flapless           | Yes             | 48  |                     |               |                         |      |    |    |                  |
| Berdougo et al.,43| Flap              | No              | 281 | 10.0-14.0           | 3.5-4.5       | Keystone                | 317  | 235|    | Con              |
|                  | Flapless           | Yes             | 271 |                     |               |                         |      |    |    |                  |
| Cannizzaro et al.,33| Flap            | No              | 67  | 10.0-14.0           | 3.7-4.8       | Swissplus, Zimmer       | NA   | NA |    | Con              |
|                  | Flapless           | No              | 76  |                     |               |                         |      |    |    |                  |
| Jeong et al., 27  | Flapless           | No              | 432 | 8.5-15              | 3.5-5.0       | ostem                   | 289  | 143|    | Con              |
| Froum et al., 44  | Flap               | Yes             | 30  | NA                 | 4.3-5.0       | Nobel Biocare           | NA   | NA |    | Con              |
|                  | Flapless           | Yes             | 30  |                     |               |                         |      |    |    |                  |
| Al-Juboori et al.,31| Flap              | No              | 11  | 10                 | 4.1-4.8       | ITI                     | 6    | 16 |    | NA               |
|                  | Flapless           | No              | 11  |                     |               |                         |      |    |    |                  |
| Tsoukaki et al.,26| Flap              | No              | 15  | NA                 | 3.5-4.0       | Astra                   | NA   | NA |    | NA               |
|                  | Flapless           | No              | 15  |                     |               |                         |      |    |    |                  |
| Parmigiani-Izquierdo et al.,45| Flap | No | NA | NA | NA | Zimmer | NA | NA |    | Con |
| Sunitha et al.,46 | Flap | No | 20 | 13-16 | 3.7-4.8 | NA | 28 | 12 | Con |
| Bashutski et al.,47| Flap | Yes | 12 | NA | 3.5-4.0 | Astra | 24 | 0  | Con |
Table 4. Summary of implant treatment outcome of the included studies.

| Author            | Follow up (months) | Type of surgery | Failures | Success rate Total (%) | Cumulative survival rate | Marginal bone loss (mm) | Pain |
|-------------------|--------------------|-----------------|----------|-------------------------|--------------------------|-------------------------|------|
| Becker et al., 24 | 24                 | Flapless        | 1        | 98.7                    | 98.7                     | 0.79                    | NA   |
| Fortin et al., 34 | NA                 | Flap            | NA       | NA                      | NA                       | NA                      | More |
| Oh et al., 40     | 6                  | flapless        | 3        | 87.5                    | 87.5                     | NA                      | NA   |
| Ozan et al., 30   | 14                 | Flap            | 1        | 98.3                    | 98.3                     | 0.6                     | NA   |
| Job et al., 25    | 6                  | Flap            | 0        | 100                     | 100                      | 0.5                     | NA   |
| Jeong et al., 28  | 6                  | Flap            | 5        | 96.47                   | NA                       | 0.26                    | NA   |
| Cannizzaro et al., 35 | 36                | Flap            | 0        | 100                     | 100                      | 0.20                    | NA   |
| Sunitha et al., 23 | 6               | Flap            | 0        | 100                     | 100                      | NA                      | Less |
| Becker et al., 29 | 44                 | Flapless        | 1        | 98.7                    | 98.7                     | 0.8                     | NA   |
| Nikzad et al., 41 | 12                 | Flapless        | 2        | 96.49                   | 96.5                     | 0.55                    | no pain |
| Van de Velde et al., 31 | 18              | Flap            | 0        | 100                     | 100                      | 1                       | Same |
| Lindeboom et al., 42 | 6              | Flap            | 4        | 98.57                   | NA                       | NA                      | Less |
| Berdougo et al., 43 | 48             | Flap            | 10       | 96.30                   | NA                       | NA                      | NA   |
| Study                  | Subjects | Implant Insertion Method | Implant Number | Success Rate | Pain Score | Stated Pain Level |
|-----------------------|----------|--------------------------|----------------|--------------|------------|------------------|
| Cannizzaro et al., 33 | 12       | Flap                     | 2              | 97           | NA         | 0.43             | More             |
|                       |          | Flapless                 | 2              | 97.3         | NA         | 0.38             | Less             |
| Jeong et al., 27      | 12       | Flapless                 | 0              | 100          | 100        | 0.3              | NA               |
| Froum et al., 44      | 12       | Flap                     | 0              | 100          | 100        | 0.60             | NA               |
|                       |          | Flapless                 | 0              | 100          | 100        | 0.24             | NA               |
| Al-Juboori et al., 31 | 6        | Flap                     | 0              | 100          | 100        | 3.75             | Mild pain        |
|                       |          | Flapless                 | 0              | 100          | 100        | 3.60             | No pain          |
| Tsoukaki et al., 28   | 6        | Flap                     | 0              | 100          | 100        | 0.29             | More             |
|                       |          | Flapless                 | 0              | 100          | 100        | 0                | Less             |
| Parmigiani-Izquierdo et al, 45 | 60  | Flap                     | NA             | NA           | NA         | NA               | More             |
|                       |          | Flapless                 | NA             | NA           | NA         | NA               | Less             |
| Sunitha et al., 46    | 24       | Flap                     | 0              | 100          | 100        | 0.47             | NA               |
|                       |          | Flapless                 | 0              | 100          | 100        | 0.09             | NA               |
| Bashutski et al., 47  | 15       | Flap                     | 1              | 92           | 92         | NA               | NA               |
|                       |          | Flapless                 | 1              | 92           | 92         | NA               | NA               |
| Meizi et al., 48      | 12       | Flap                     | 3              | 97.2         | NA         | NA               | NA               |
|                       |          | Flapless                 | 7              | 97.1         | NA         | NA               | NA               |
| Pozzi et al., 49      | 12       | Flapless                 | 1              | 99.5         | NA         | 0.8              | Less pain in computer guided group |
| Malo et al., 50       | 36       | Flap                     | 0              | NA           | 100        | 1.14             | NA               |
|                       |          | Flapless                 | 1              | NA           | 96.9       | 1.60             | NA               |
| Maier et al., 51      | 12       | Flap                     | 1              | 99.03        | NA         | 0.55             | NA               |
|                       |          | Flapless                 | 1              | 99.03        | NA         | 0.09             | NA               |
| Pisoni et al., 52     | 36       | Flap                     | NA             | NA           | NA         | 0.174            | NA               |
|                       |          | Flapless                 | NA             | NA           | NA         | 0.198            | NA               |
| Prati et al., 53      | 36       | Flap                     | 1              | 98.5         | NA         | 1.23             | NA               |
|                       |          | Flapless                 | 2              | 96.97        | NA         | 1.22             | NA               |
| Wang et al., 54       | 24       | Flap                     | 0              | 100          | NA         | 0.4              | Higher           |
|                       |          | Flapless                 | 0              | 100          | NA         | 0.5              | Lower            |

NA: Not available.

**Age**

The age of the patients ranged in between 18 and 86 years. Age range was not reported in two studies. 23,43

**Gender**

Only six studies23,25,47,54,55 did not mention the gender distribution in their study. In the other 24 studies a total of 627 females and a total of 597 male patients were included.

**Surgical methods**

Table 3 describes number of implants and their features as well as implant insertion site and loading protocol.

Seven studies24,27,29,40,41,48,58 used flapless surgical technique only while comparison of flapless and flapped techniques was performed in the other 21 studies. In studies by Pozzi et al.,18 and Tallarico et al.,58 comparison of computer guided and manual implant insertion both with flapless technique was performed. In 10 trials,30,32,34,35,41-43,46,48,58 implant insertion was performed using computer guided equipment.

**Implant features**

One study44 did not report the exact number of implants. A total number of 3047 implants were inserted.
in the other included studies, the length and diameter of implants ranged between 8mm to 16mm and 3.3mm to 5mm in 23 studies, respectively. All implants in the included studies had smooth surface while implant surface was calcium phosphate coated in the study of Prati et al. The following implant systems were used in the selected studies: Swiss plus*, Zimmer*, ITI*, Astra*, Easy implant, Nobel Biocare, Single piece root, Ostem, Dentsply, Cortex, MicroDent, and TiLobe.

**Site of implant insertion**

Nineteen studies reported implant insertion site. In these studies, 1363 implants were inserted in the maxilla while 1081 implants were inserted in the mandible.

**Loading protocol**

In the studies of Job et al., Malo et al., and Tallarico et al., all implants were loaded immediately and in four other studies immediate implant loading was only done using flapless technique. In the other studies, implants were loaded following conventional protocols.

**Implant treatment outcome**

Outcome of implant treatment is demonstrated in the following categories:

**Implant success and survival rate**

While no significant difference was found between success and survival rate of implants using the two different techniques, Jeong et al., reported higher success rate in flapless group.

**Alveolar bone loss**

Twelve studies reported higher marginal bone loss in flapped groups compared to flapless technique. However, the difference was not significant in eight studies. In the studies of Malo et al., and Pisoni et al., marginal bone loss was higher in the flapless group, however Malo et al., reported no statistical analysis for comparison between two groups and Pisoni et al. showed no significant difference between the two groups. In the RCTs by Bömicke et al. and Kumar et al. marginal bone loss was significantly lower in the flapless group.

**Post-operative complications**

Although in nine studies less pain was reported following flapless technique, in the study of Lindeboom et al. the flapless group reported more pain. In addition, less edema in the flapless group was reported by Cannizzaro et al., and shorter surgical time using flapless technique was reported in two studies.

The study of Jané-Salas et al. showed that the patients in the flapless group had less complications, pain and mouth opening reduction compared to the patients in the flap group.

**DISCUSSION.**

When lost teeth will be substituted by dental implants, several factors concerning dental implant properties and surgical and prosthetic methods should be considered in order to increase success rate of the treatment as well as patient satisfaction. The clinician should use proper materials and methods in each case. One of the important factors that thought to affect implant treatment outcome is flap design at the time of implant insertion. In clinical situations, the surgeon should choose between flapped and flapless approaches prior to the implant insertion procedure. Each of these approaches has been reported to have its own advantages and disadvantages. While flapped technique permits visual evaluation of the insertion site, flapless approach is associated with less surgical time and less patient discomfort. However, in recent dentistry, such clinical decision making should be evidence-based. Systematic reviews can provide reliable evidence through the gathering of information from previous single clinical trials.

The aim of the current study was to systematically review the articles comparing implant treatment outcome between flapped and flapless implant insertion techniques. The results were categorized based on implant survival rate, amount of marginal bone loss and post-operative complications. The results indicate no difference in implant survival rate while the flapless technique seems to be associated with comparable or less marginal bone loss and less pain and discomfort. Previously, some studies have reviewed and compared these techniques and reported comparable outcome.

Lin et al. performed a meta-analysis for comparison of survival rate and marginal bone loss in flapped and flapless techniques. They included 12 studies with...
different designs and showed that the mean survival rate of implants in flapped and flapless techniques was 98.6% and 97%, respectively. No statistically difference was found when the difference was analysed considering study design. Also comparison of the mean marginal bone loss showed a difference of 0.03mm, a result that was also was not statistically different between the two surgical techniques. A systematic review by Chen et al.\textsuperscript{63} showed similar survival rate and clinical outcome between implants inserted immediately and those inserted using a delayed approach in healed sites. In a review of Vohra et al.\textsuperscript{5} only studies that inserted dental implants in healed alveolar ridge were included. Ten studies were included that showed that in half of those studies there was no difference in marginal bone loss between the two techniques while the other half reported less marginal bone loss in the flapless groups.

In comparison to mentioned reviews,\textsuperscript{5,36} a meta-analysis by Chrcanovic et al.\textsuperscript{37} showed a significantly higher implant survival rate in the flapped group compared to the flapless group. The analysis included 23 studies and the reported odds ratio of implant failure in flapless technique compared to flapped technique was 1.75 ($p=0.04$). This means that implant placement using flapless technique increased the risk of implant failure by 75%. The reason for this controversy might be due to the fact that in their review, all studies comparing implant treatment outcome between flapped and flapless technique were included regardless of sample size, study design and follow up period. They also compared post-operative complication of flapped and flapless techniques and showed no significant difference. Similar to the other reviews,\textsuperscript{5,36} comparison of mean marginal bone loss between flapped and flapless techniques in the study of Chrcanovic et al.\textsuperscript{37} showed no significant difference. A systematic review by Moraschini et al.\textsuperscript{12} was performed on implant treatment outcome using flapless technique only. They included 13 studies from PubMed and Cochrane databases and revealed that flapless technique would result in 97.2% survival rate and a mean 1.45mm marginal bone loss during 1-4 years of follow up. In the meta-analysis studies which placed more than five implants in each patient were included. It is mentioned that surgical and prosthetic complications may happen using this technique and more studies are required to more precisely assess flapless technique. Another two reviews on outcome of dental implant treatment in flapless technique show 98.6\textsuperscript{10} and 97.1%\textsuperscript{31} of survival rate and a rate of post-operative complication of 3.8\textsuperscript{20} and 6.55%\textsuperscript{31} using this technique.

Regarding the level of evidence, 21 out of 32 reviewed studies were randomized clinical trials (RCTs).\textsuperscript{16,30,31,33-35,40,42-44,48,51,53-58} The exclusive results of these studies were similar to the results of all studies combined. In RCTs, no difference in implant survival rate between both techniques were found. Five RCTs\textsuperscript{26,43,45,55,57} reported higher marginal bone loss in flapped groups compared to flapless technique while the differences were not significant in six RCTs.\textsuperscript{30-33,53,54} All nine studies that reported less post-operative pain in flapless approach\textsuperscript{26,31,33-35,44,53,56-57} were RCTs. However, Another RCT\textsuperscript{62} reported more pain in the flapless group. Less edema in flapless group was reported in the RCT by Cannizzaro et al.\textsuperscript{35} and shorter surgical time using flapless technique was reported in another RCT by Cannizzaro et al.\textsuperscript{35}

Some factors could influence implant treatment outcome which were not considered in this review. Gingival biotype could influence implant treatment outcome as the facial bone loss in thick biotypes is less than 1 mm while it is 1-1.5mm in thin biotypes.\textsuperscript{64} Also, oral hygiene has an important role in the success of dental implant treatment\textsuperscript{65} which was not considered in the included studies. A definitive factor which could influence survival rate of dental implants is smoking. Marginal bone loss has been demonstrated to be increased in smokers compared to non-smokers.\textsuperscript{66} It has been stated that survival rate of implant for non-smokers and smokers using flapless technique is 98.9% and 81.2%, respectively and the extent of marginal bone loss was 1.2 and 2.6mm, respectively.\textsuperscript{67} However, none of the reviewed studies reported implant treatment outcome in flapped and flapless groups based on patients smoking habits. Finally, the experience of the surgeon also could influence treatment outcome\textsuperscript{68} as some surgeons may be more skilful in flapped technique while others may prefer flapless technique.

The results of this review could be interpreted into clinical situations considering the inclusion criteria of the
reviewed studies. The results indicate comparable clinical outcome of both techniques. In the included RCTs, healthy patients who needed implant insertion in alveolar bone without augmentation were enrolled. In these situations, the surgeon is free to choose between both techniques. The results of this review could not be used in patients with compromised conditions, systemic diseases or those with insufficient bone at the recipient site.

The limitations of this systematic review should also be considered. Most studies were RCT (n=21). Also, the method of the studies including study design, duration and periods of follow ups, protocols for loading dental implants, insertion of dental implants in healed, fresh socket or augmented sites, smoking, and implant site, differed. In addition, the included studies assess marginal bone loss by comparing periapical radiographs. However, this technique might not be able to properly show amount of facial bone loss. Finally, this review only included studies in the English language and is prone to publication bias.

Further well designed randomized controlled trials should be performed with longer follow ups and larger sample sizes to further investigate this issue. It is suggested to consider patient hygiene, smoking, soft tissue biotype, previous procedures on the recipient site, protocols for loading dental implants, and implant site. Future studies should be performed to investigate the effect of the aforementioned factors on implant treatment outcomes and compare implant success rate, marginal bone loss and rate of complications between flapped and flapless groups considering these factors. Also, it is suggested to perform RCTs measuring amount of facial bone loss using cone bean computed tomography (CBCT) considering ethical issues.

CONCLUSION.

Considering the limitations of this systematic review, the results could be summarized as follows:

There was no significant difference in success and survival rate of implants between two techniques except for one study that reported higher success rate in flapless group. Therefore, implant survival rate using flapped and flapless technique is comparable.

Twelve studies reported higher marginal bone loss in flapped groups compared to flapless technique. Six of these studies were RTCs. However, the difference was not significant in eight studies, five of them RCTs. So, marginal bone loss using flapless technique is similar or less than using flapless technique.

Less post-operative pain in flapless group compared to flapped group was reported in nine RCTs while flapless group reported more pain in another RCT. Less edema in flapless group was reported in nine RCTs while flapless group reported more edema in another RCT.

Shorter surgical time using flapless technique was reported in two studies and one RCT.

REFERENCES.

1. Ormianer Z, Palti A. Long-term clinical evaluation of tapered multi-threaded implants: results and influences of potential risk factors. J Oral Implantol. 2006;32(6):300–7.
2. Jokstad A, Braegger U, Brunski JB, Carr AB, Naert I, Wennenber A. Quality of dental implants. Int Dent J. 2003;53(6 Suppl 2):409–43.
3. Behnia H, Motamedian SR, Kiani MT, Morad G, Khojasteh A. Accuracy and reliability of cone beam computed tomographic measurements of the bone labial and palatal to the maxillary anterior teeth. Int J Oral Maxillofac Implants. 2015;30(6):1249–55.
4. Morad G, Behnia H, Motamedian SR, Shahab S, Gholamin P, Khosraviani K, Nowzari H, Khojasteh A. Thickness of labial alveolar bone overlying healthy maxillary and mandibular anterior teeth. J Craniofac Surg. 2014;25(6):1985–91.
5. Vohra F, Al-Kheraif AA, Almas K, Javed F. Comparison of crestal bone loss around dental implants placed in healed sites using flapped and flapless techniques: a systematic review. J Periodontol. 2015;86(2):185–91.
6. Khojasteh A, Motamedian SR, Sharifzadeh N, Zadeh HH. The influence of initial alveolar ridge defect morphology on the outcome of implants in augmented atrophic posterior mandible: an exploratory retrospective study. Clin Oral Implants Res. 2017;28(10):c208–17.
7. Khojasteh A, Hassani A, Motamedian SR, Saadat S, Alikhasi M. Cortical Bone Augmentation Versus Nerve Lateralization for Treatment of Atrophic Posterior Mandible: A Retrospective Study and Review of Literature. Clin Implant Dent Relat Res. 2016;18(2):342–59.
8. Hosseinpour S, Ghazizadeh Ahsaie M, Rezai Rad M, Baghani MT, Motamedian SR, Khojasteh A. Application of selected scaffolds for bone tissue engineering: a systematic review. Oral Maxillofac Surg. 2017;21(2):109–29.
9. Motamedian SR, Tabatabaei FS, Akhlaghi F, Torshabi M, Gholamin P, Khojasteh A. Response of Dental Pulp Stem Cells and Synthetic, Allograft, and Xenograft Bone Scaffolds. Int J Oral Res 2018;7(7):324-335 doi:10.17126/joralres.2018.070
11. Cecchinato D, Lops D, Salvi GE, Sanz M. A prospective, randomized, controlled study using OsseoSpeed™ implants placed in maxillary fresh extraction socket: soft tissue response. Clin Oral Implants Res. 2015;26(1):20–7.

12. Khorsand A, Rasouli-Ghahroudi AA, Naddafpour Y, Shayesteh YS, Khajosteh A. Effect of Microthread Design on Marginal Bone Level Around Dental Implants Placed in Fresh Extraction Sockets. Implant Dent. 2016;25(1):90–6.

13. Stoupel J, Lee CT, Glick J, Sanz-Miralleles E, Chiuwan C, Papapanou PN. Immediate implant placement and provisionalization in the aesthetic zone using a flapless or a flap-involving approach: a randomized controlled trial. J Clin Periodontol. 2016;43(12):1171–9.

14. Costich ER, Ramford SP. Healing after partial denudation of the alveolar process. J Periodontol. 1968;39(3):127–34. [PubMed]

15. Campelo LD, Camara JR. Flapless implant surgery: a 10-year clinical retrospective analysis. Int J Oral Maxillofac Implants. 2002;17(2):271–6.

16. Cosyn J, Sabzevar MM, De Bruyn H. Predictors of interproximal and midfacial recession following single implant treatment in the anterior maxilla: a multivariate analysis. J Clin Periodontol. 2012;39(9):895–903.

17. Chen ST, Darby IB, Reynolds EC, Clement JC. Immediate implant placement postextraction without flap elevation. J Periodontol. 2009;80(1):163–72.

18. Elskary A. Fundamentals of Esthetic Dentistry. 2th Ed. Wiley-Blackwell; 2008.

19. Scala R, Ghenspi C, Cucchi A, Pistoia E. Postextraction implant placement with immediate provisionalisation and finalisation, using a simplified technique: technical notes and a case report. Open Dent J. 2012;6:164–9.

20. Brodala N. Flapless surgery and its effect on dental implant outcomes. Int J Oral Maxillofac Implants. 2009;24(Suppl):118–25.

21. Doan NV, Du Z, Reher P, Xiao Y. Flapless dental implant surgery: a retrospective study of 1,241 consecutive implants. Int J Oral Maxillofac Implants. 2014;29(3):650–8.

22. Moraschini V, Velloso G, Luz D, Barbosa EP. Implant survival rates, marginal bone level changes, and complications in full-mouth rehabilitation with flapless computer-guided surgery: a systematic review and meta-analysis. Int J Oral Maxillofac Surg. 2015;44(7):892–901.

23. Sunitha RV, Ramakrishnan T, Kumar S, Emmadi P. Soft tissue preservation and crestal bone loss around single-tooth implants. J Oral Implantol. 2008;34(4):223–9.

24. Becker W, Goldstein M, Becker BE, Sennerby L. Minimally invasive flapless implant surgery: a prospective multicenter study. Clin Implant Dent Relat Res. 2005;7(Suppl 1):S21–7.

25. Job S, Bhat V, Naidu EM. In vivo evaluation of crestal bone heights following implant placement with 'flapless' and 'with-flap' techniques in sites of immediately loaded implants. Indian J Dent Res. 2008;19(4):320–5.

26. Tsoukaki M, Kalpidis CD, Sakellari D, Tsalikis L, Mikrogiorghis G, Konstantinidis A. Clinical, radiographic, microbiological, and immunological outcomes of flapped vs. flapless dental implants: a prospective randomized controlled clinical trial. Clin Oral Implants Res. 2013;24(9):969–76.

27. Jeong SM, Choi BH, Kim J, Xuan F, Lee DH, Mo DY, Lee CU. A 1-year prospective clinical study of soft tissue conditions and marginal bone changes around dental implants after flapless implant surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2011;111(1):41–6.

28. Jeong SM, Choi BH, Li J, Ahn KM, Lee SH, Xuan F. Bone healing around implants following flap and mini-flap surgeries: a radiographic evaluation between stage I and stage II surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008;105(3):293–6.

29. Becker W, Goldstein M, Becker BE, Sennerby L, Kois D, Hujoe P. Minimally invasive flapless implant placement: follow-up results from a multicenter study. J Periodontol. 2009;80(2):347–52.

30. Ozan O, Turkyilmaz I, Yilmaz B. A preliminary report of patients treated with early loaded implants using computerized tomography-guided surgical stents: flapless versus conventional flapped surgery. J Oral Rehabil. 2007;34(11):835–40.

31. Al-Juboori MJ, Bin Abdulrahman S, Jassan A. Comparison of flapless and conventional flap and the effect on crestal bone resorption during a 12-week healing period. Dent Implantol Update. 2012;23(2):9–16.

32. Van de Velde T, Sennerby L, De Bruyn H. The clinical and radiographic outcome of implants placed in the posterior maxilla with a guided flapless approach and immediately restored with a provisional rehabilitation: a randomized clinical trial. Clin Oral Implants Res. 2010;21(11):1223–33.

33. Cannizzaro G, Felice P, Leone M, Checchi V, Esposito M. Flapless versus open flap implant surgery in partially edentulous patients subjected to immediate loading: 1-year results from a split-mouth randomised controlled trial. Eur J Oral Implantol. 2011;4(3):177–88.

34. Fortin T, Bosson JL, Isidori M, Blanchet E. Effect of flapless surgery on pain experienced in implant placement using an image-guided system. Int J Oral Maxillofac Implants. 2006;21(2):298–304.

35. Cannizzaro G, Leone M, Consono U, Ferri V, Esposito M. Immediate functional loading of implants placed with flapless surgery versus conventional implants in partially edentulous patients: a 3-year randomized controlled clinical trial. Int J Oral Maxillofac Implants. 2008;23(5):867–75.

36. Lin GH, Chan HL, Bashutski JD, Oh TJ, Wang HL. The effect of flapless surgery on implant survival and marginal bone level: a systematic review and meta-analysis. J Periodontol. 2014;85(5):e91–103.

37. Chrcanovic BR, Albrektsson T, Wennberg A. Flapless versus conventional flapped dental implant surgery: a meta-analysis. PLoS One. 2014;9(6):e100624.

38. Tehranchi A, Motamedian SR, Saedi S, Kabiri S, Shidfar S. Correlation between frontal sinus dimensions and cephalometric indices: A cross-sectional study. Eur J Dent. 2017;11(1):64–70.

39. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gotzsche PC, Ioannidis JP, Clarke M, Devereaux PJ, Kleijnen J, Moher D. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. Ann Intern Med. 2009;151(4):W65–94.

40. Oh TJ, Shotwell JL, Billy EJ, Wang HL. Effect of flapless implant surgery on soft tissue profile: a randomized controlled clinical trial. J Periodontol. 2006;77(5):874–82.

41. Nikzad S, Azari A. Custom-made radiographic template, computed tomography, and computer-assisted flapless surgery for treatment planning in partial edentulous patients: a prospective 12-month study. J Oral Maxillofac Surg. 2010;68(6):1353–9.

42. Lindeboom JA, van Wijk AJ. A comparison of two implant techniques on patient-based outcome measures: a report of flapless vs. conventional flapless implant placement. Clin Oral Implants Res. 2010;21(4):366–70.

43. Froum SJ, Cho SC, Elian N, Romanos G, Jalbout Z, Natour M, Norman R, Neri D, Tarnow DP. Survival rate of one-piece dental implants placed with a flapless or flap protocol—a randomized, controlled study: 12-month results. Int J Periodontics Restorative Dent. 2011;31(6):591–601.

44. Parmigiani-Izquierdo JM, Sánchez-Pérez A, Cabaña-Muñoz ME. A pilot study of postoperative pain felt after two implant surgery techniques: a randomized blinded prospective clinical study. Int J Oral Maxillofac Implants. 2013;28(5):1305–10.
45. Sunitha RV, Sapthagiri E. Flapless implant surgery: a 2-year follow-up study of 40 implants. Oral Surg Oral Med Oral Pathol Oral Radiol. 2013;116(4):e237–43.
46. Bashutski JD, Wang HL, Rudek I, Moreno I, Koticha T, Oh TJ. Effect of flapless surgery on single-tooth implants in the esthetic zone: a randomized clinical trial. J Periodontol. 2013;84(12):1747–54.
47. Meizi E, Meir M, Laster Z. New-design dental implants: a 1-year prospective clinical study of 344 consecutively placed implants comparing immediate versus delayed loading and flapless versus full-thickness flap. Int J Oral Maxillofac Implants. 2014;29(1):e14–21.
48. Pozzi A, Tallarico M, Marchetti M, Scarfò B, Esposito M. Computer-guided versus free-hand placement of immediately loaded dental implants: 1-year post-loading results of a multicentre randomised controlled trial. Eur J Oral Implantol. 2014;7(3):229–42.
49. Maló P, de Araújo Nobre M, Lopes A. Three-Year Outcome of Fixed Partial Reha bilitations Supported by Implants Inserted with flapless or Flapless Surgical Techniques. J Prosthodont. 2016;25(5):357–63.
50. Maier FM. Initial Crestal Bone Loss After Implant Placement with Flapped or Flapless Surgery-A Prospective Cohort Study. Int J Oral Maxillofac Implants. 2016;31(4):876–83.
51. Pisoni L, Ordesi P, Siervo P, Bianchi AE, Persia M, Siervo S. Flapless Versus Traditional Dental Implant Surgery: Long-Term Evaluation of Crestal Bone Resorption. J Oral Maxillofac Surg. 2016;74(7):1354–9.
52. Prati C, Zamparini F, Scialabba VS, Gatto MR, Piattelli A, Montebugnoli L, Gandolfi MG. A 3-Year Prospective Cohort Study on 132 Calcium Phosphate-Blasted Implants: Flap vs Flapless Technique. Int J Oral Maxillofac Implants. 2016;31(2):413–23.
53. Wang F, Huang W, Zhang Z, Wang H, Monje A, Wu Y. Minimally invasive flapless vs. flapped approach for single implant placement: a 2-year randomized controlled clinical trial. Clin Oral Implants Res. 2017;28(6):675–64.
54. Froum SJ, Khouly I. Survival Rates and Bone and Soft Tissue Level Changes Around One-Piece Dental Implants Placed with a Flapless or Flap Protocol: 8.5-Year Results. Int J Periodontics Restorative Dent. 2017;37(3):327–37.
55. Bömnicke W, Gabbert O, Koob A, Krisam J, Rammelsberg P. Comparison of immediately loaded flapless-placed one-piece implants and flapped-placed conventionally loaded two-piece implants, both fitted with all-ceramic single crowns, in the posterior mandible: 3-year results from a randomised controlled pilot trial. Eur J Oral Implantol. 2017;10(2):179–95.
56. Jané-Salas E, Roselló-Llabrés X, Jané-Pallí E, Mishra S, Ayuso-Montero R, López-López J. Open flap versus flapless placement of dental implants. A randomized controlled pilot trial. Odontology. 2008;106(3):340–8.
57. Kumar D, Sivaram G, Shivakumar B, Kumar T. Comparative evaluation of soft and hard tissue changes following endosseous implant placement using flap and flapless techniques in the posterior edentulous areas of the mandible-a randomized controlled trial. Oral Maxillofac Surg. 2018;[Epub ahead of print].
58. Tallarico M, Esposito M, Xhanari E, Caneva M, Meloni SM. Computer-guided vs freehand placement of immediately loaded dental implants: 5-year postloading results of a randomised controlled trial. Eur J Oral Implantol. 2018;11(2):203–13.
59. Berdougo M, Fortin T, Blanchet E, Isidori M, Bosson JL. Flapless implant surgery using an image-guided system. A 1- to 4-year retrospective multicenter comparative clinical study. Clin Implant Dent Relat Res. 2010;12(2):142–52.
60. Bhat V, Bangawala MR. Immediate implant placement without flap elevation - A review. NUIHS. 2014;4(3):131–7.
61. al-Ansari BH, Morris RR. Placement of dental implants without flap surgery: a clinical report. Int J Oral Maxillofac Implants. 1998;13(6):861–5.
62. Eslamipour F, Motamad SR, Bagheri F. Ibuprofen and Low-level Laser Therapy for Pain Control during Fixed Orthodontic Therapy: A Systematic Review of Randomized Controlled Trials and Meta-analysis. J Contemp Dent Pract. 2017;18(6):527–33.
63. Chen ST, Wilson TG Jr, Hämmerle CH. Immediate or early placement of implants following tooth extraction: review of biologic basis, clinical procedures, and outcomes. Int J Oral Maxillofac Implants. 2004;19 Suppl:1–25.
64. Chen ST, Darby IB, Reynolds EC, Clement JC. Immediate implant placement postextraction without flap elevation. J Periodontol. 2009;80(1):163–72.
65. Serino G, Turri A, Lang NP. Maintenance therapy in patients following the surgical treatment of peri-implantitis: a 5-year follow-up study. Clin Oral Implants Res. 2015;26(8):950–6.
66. Vervaeke S, Collaert B, Vandeweghe S, Cosyn J, Deschepper E, De Bruyn H. The effect of smoking on survival and bone loss of implants with a fluoride-modified surface: a 2-year retrospective analysis of 1106 implants placed in daily practice. J Prosthet Dent. 2007;97(6):331–9.
67. Sanna AM, Molly L, van Steenbergh D. Immediately loaded CAD-CAM manufactured fixed complete dentures using flapless implant placement procedures: a cohort study of consecutive patients. J Prosthodont. 2007;16(6):331–9.
68. Cusen SE, Turkayilmaz I. Impact of operator experience on the accuracy of implant placement with stereolithographic surgical templates: an in vitro study. J Prosthodont. 2013;109(4):248–54.