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Review

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.

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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 implants[1] 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 reconstructive[6,7] or regenerative procedures[8,9]may be needed. Several tecnhiques 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

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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.[13] 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.[14]

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.[15] 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.[16] This approach is generally indicated for specific patients such as those who demand esthetic treatments, implants placed in esthetic areas,[17,18] fractured teeth,[18] endodontic failures, non-restorable caries, and radicular caries.[19] 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.[19]

Implant treatment outcomes by flapless approach have been reviewed previously.[20-22] 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.[22] Another review also showed that using flapless technique the implant survival rate was 98.6% with 3.8% complication rate.[20] Flapless technique had 97.1% and 6.55% survival and complication rates respectively, for implants placed in the maxillary posterior region.[21]

Comparison of implant treatment outcome and complications between flapped and flapless groups has been performed is some clinical studies,[23-35] and systematic reviews[5,36,37] 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.[38]

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.[39] 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,[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[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.

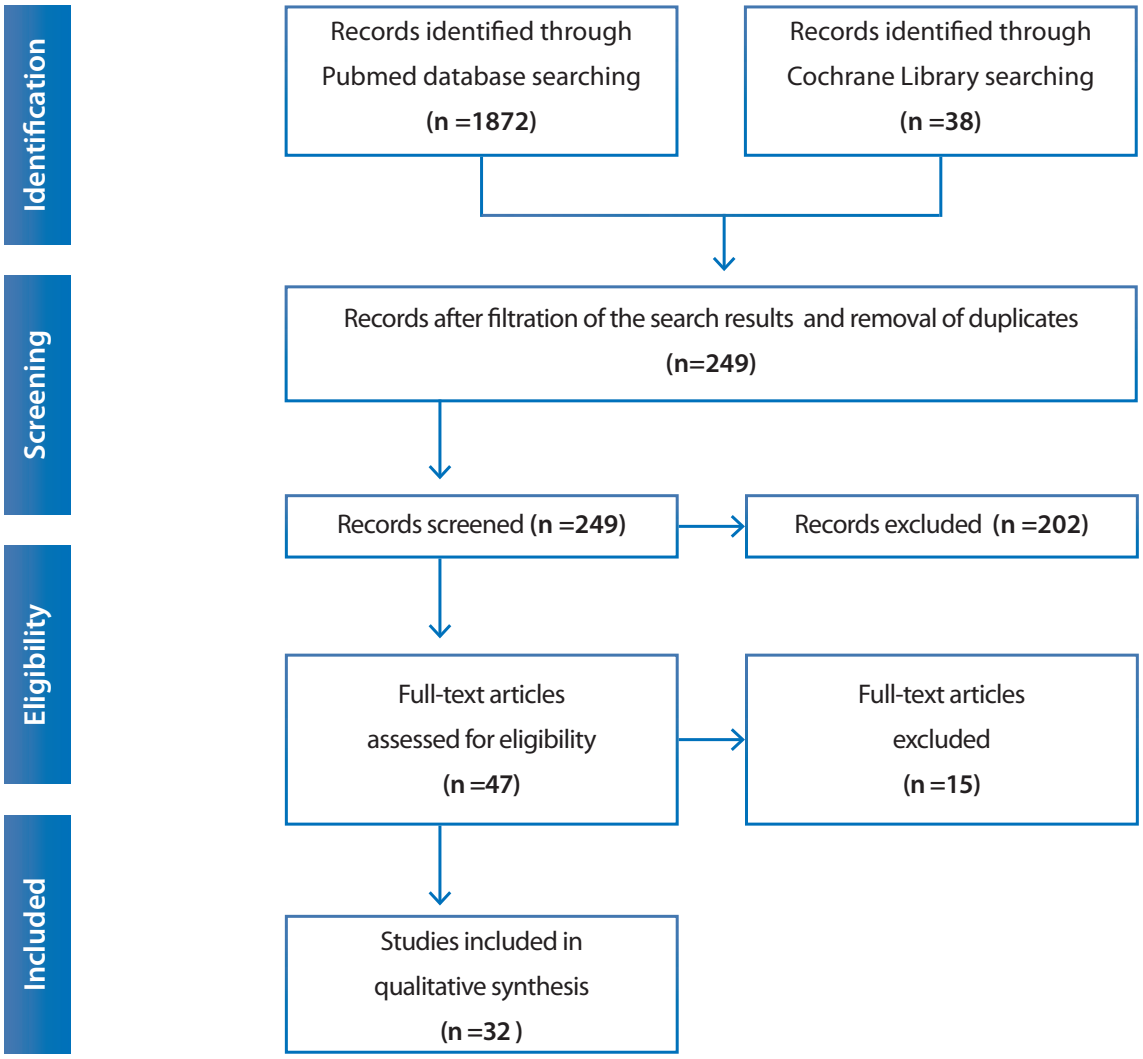

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Table 1. Relevant keywords used for electronic search.

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.*,[23]	2008	Prospective	10	NA	NA
Becker *et al.*,[24]	2005	Prospective	57	24-86	33
Job *et al.*,[25]	2008	Prospective	6	35-55	NA
Tsoukaki *et al.*,[26]	2013	RCT	20	30-62	11
Jeong *et al.*,[27]	2011	Prospective	241	19-73	133
Jeong *et al.*,[28]	2008	Prospective	129	19-73	71
Becker *et al.*,[29]	009	Prospective	57	24-86	33
Ozan *et al.*,[30]	2007	RCT	12	42-51	7
Al-Juboori *et al.*,[31]	2012	RCT	9	27-62	6
Van de Velde *et al.*,[32]	2010	RCT	14	39-75	9
Cannizzaro *et al.*,[33]	2011	RCT	40	22-65	NA
Fortin *et al.*,[34]	2006	RCT	60	19-82	38
Cannizzaro *et al.*,[35]	2008	RCT	40	18-64	10
Oh *et al.*,[40]	2006	RCT	57	31-61	14
Nikzad *et al.*,[41]	2010	Prospective	16	42-66	7
Lindeboom *et al.*,[42]	2010	RCT	16	51-65	13
Berdougo *et al.*,[43]	2010	-	169	20-48	111
Froum *et al.*,[44]	2011	RCT	60	NA	35
Parmigiani-Izquierdo *et al.*,[45]	2013	RCT	19	41-59	4
Sunitha *et al.*,[46]	2013	RCT	40	25-62	15
Bashutski *et al.*,[47]	2013	RCT	24	22-78	14
Meizi *et al.*,[48]	2014	Prospective	155	47.5	NA
Pozzi *et al.*,[49]	2014	RCT	51	28-84	24
Malo *et al.*,[50]	2016	Prospective	41	19-79	22
Maier *et al.*,[51]	2016	Prospective	80	18-78	50
Pisoni *et al.*,[52]	2016	RCT	40	61.69	9
Prati *et al.*,[53]	2016	Prospective	60	25-72	26
Wang *et al.*,[54]	2017	RCT	40	19-45	14

RCT: Randomized controlled trial. **NA:** Not available.

Table 3. Summary of included studies regarding surgical technique.

Authors	Surgical techique	Computer guided	No.	Implant Length (mm)	Diameter (mm)	System	Site Mx	Site 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
	Flapless	Yes	80						NA
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						Con
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
	Flapless	No	10						Con
Becker *et al.*, [29]	Flapless	No	79	NA	NA	Nobel Biocare	NA	NA	Con
Nikzad *et al.*, [41]	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						Con
Cannizzaro *et al.*, [33]	Flap	No	67	10.0-14.0	3.7-4.8	Swissplus, Zimmer	NA	NA	Con
	Flapless	No	76						Con
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	Flap	No	NA	NA	NA	Zimmer	NA	NA	Con
et al., [45]	Flapless	No	NA						Con
Sunitha *et al.*, [46]	Flap	No	20	13-16	3.7-4.8	NA	28	12	Con
	Flapless	No	20						Con
Bashutski *et al.*, [47]	Flap	Yes	12	NA	3.5-4.0	Astra	24	0	Con
	Flapless	Yes	12						

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Meizi *et al.*, [48]	Flap	No	107	NA	NA	Cortex	NA	NA	Imm & Con
	Flapless	No	237						Imm & Con
Pozzi *et al.*, [49]	Flapless	Yes	103	7-15	3.3-5	Nobel Biocare	123	79	Imm
	Flapless	No	99						
Malo *et al.*, [50]	Flap	No	32	10-15	>4	Nobel Biocare	51	21	Imm
	Flapless	No	40						Imm
Maier *et al.*, [51]	Flap	No	100	9.5-14	3.5-4.5	Dentsply	NA	NA	Con
	Flapless	No	95						Con
Pisoni *et al.*, [52]	Flap	No	30	NA	4.1	ITI	3	27	Con
	Flapless	No	39				6	33	Con
Prati *et al.*, [53]	Flap	No	66	NA	3.5-5	TiLobe	57	75	Con
	Flapless	No	66						Con
Wang *et al.*, [54]	Flap	No	20	8-12	4.1-4.8	ITI	NA	NA	Con
	Flapless	No	20	8-12	4.1-4.8				Con

No.: Number. Mx: Maxilla. **Mn:** Mandible. **NA:** Not available. **Con:** Conventional. **Imm:** Immediate.

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
		Flapless	NA	NA	NA	NA	Less
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
		Flapless	0	100	100	0.5	NA
Job *et al.*, [25]	6	Flap	0	100	NA	0.09-0.40	NA
		Flapless	0	100	NA	0.01-0.06	NA
Jeong *et al.*, [28]	6	Flap	5	96.47	NA	0.26	NA
		Flapless	0	100	NA	0.20	NA
Cannizzaro *et al.*, [35]	36	Flap	0	100	100	NA	More
		Flapless	0	100	100	NA	Less
Sunitha *et al.*, [23]	6	Flap	0	100	NA	1.01	NA
		Flapless	0	100	NA	0.68	NA
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.*, [32]	18	Flap	0	100	100	1	Same
		Flapless	1	97.3	97.3	0.77	Same
Lindeboom *et al.*, [42]	6	Flap	NA	NA	NA	NA	Less
		Flapless	NA	NA	NA		More
Berdougo *et al.*, [43]	48	Flap	4	NA	98.57	NA	NA
		Flapless	10	NA	96.30	NA	NA

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.,* [26]	6	Flap	0	100	100	0.29	more
		Flapless	0	100	100	0	less
Parmigiani-Izquierdo	60	Flap	NA	NA	NA	NA	More
et al., [45]		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 studies[23,25,33,47,54,55] 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 studies[24,27,29,40,41,48,58] 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.,*[48] 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 study[44] did not report the exact number of implants. A total number of 3047 implants were inserted

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in the other included studies. The length and diameter of implants ranged between 8mm to 16mm and 3.3mm to 5mm in 23 studies,[23-27,30-33,35,40,41,43,45,46,48-50,52-55] respectively. All implants in the included studies had rough surface while implant surface was calcium phosphate coated in the study of Prati *et al.,*[52] 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[24,27,28,30-32,35,40-42,45,46,48,49,51,52,55-57] 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.,*[25] Malo *et al.,*[49] and Tallarico *et al.,*[58] all implants were loaded immediately and in four other studies[32,35,40,48] 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 table 4. The implant treatment results of the included studies were compared 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.,*[28] reported higher success rate in flapless group.

Alveolar bone loss

Twelve studies[23-27,43,45,50,52,53,55,57] reported higher marginal bone loss in flapped groups compared to flapless technique. However, the difference was not significant in eight studies.[28-33,52,53] In the studies of Malo *et al.,*[49] and Pisoni *et al.,*[51] marginal bone loss was higher in the flapless group, however Malo *et al.,*[49] reported no statistical analysis for comparison between two groups and Pisoni *et al.*[51] showed no significant difference between the two groups. In the RCTs by Bömicke *et al.*[55] and Kumar *et al.*[57] marginal bone loss was significantly lower in the flapless group.

Post-operative complications

Although in nine studies[26,31,33-35,44,53,56,57] less pain was reported following flapless technique, in the study of Lindeboom *et al.*[42] the flapless group reported more pain. In addition, less edema in the flapless group was reported by Cannizzaro *et al.,*[35] and shorter surgical time using flapless technique was reported in two studies.[24,33]

The study of Jané-Salas *et al.,*[56] 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.[20,21] 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,[60] flapless approach is associated with less surgical time[24,33] and less patient discomfort.[26,31,61] 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.[62]

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.[5, 36, 37]

Lin *et al.,*[36] 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.*[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.*[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,[5,36] a meta-analysis by Chrcanovic *et al.,*[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,[5,36] comparison of mean marginal bone loss between flapped and flapless techniques in the study of Chrcanovic *et al.*[37] showed no significant difference. A systematic review by Moraschini *et al.*[22] 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%[20] and 97.1%[21] of survival rate and a rate of post-operative complication of 3.8%[20] and 6.55%[21] using this technique.

Regarding the level of evidence,21 out of 32 reviewed studies were randomized clinical trials (RCTs).[26,30,31,33-35,40,42-46,48,51,53-58] 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[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.[30-33,53,54] All nine studies that reported less post-operative pain in flapless approach[26,31,33-35,44,53,56,57] were RCTs. However, Another RCT[42] reported more pain in the flapless group. Less edema in flapless group was reported in the RCT by Cannizzaro *et al.,*[35] and shorter surgical time using flapless technique was reported in another RCT by Cannizzaro *et al.*[33]

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.[64] Also, oral hygiene has an important role in the success of dental implant treatment[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.[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.[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[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

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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 flapped 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 a RCT. Therefore, it seems that flapless technique would probably have less post-operative pain and edema.

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

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