

Review

Effects of Currently Available Surgical and Restorative Interventions on Reducing Midfacial Mucosal Recession of Immediately Placed Single-Tooth Implants: A Systematic Review

Guo-Hao Lin,*† Hsun-Liang Chan,‡ and Hom-Lay Wang‡

Background: Procedures to improve peri-implant soft-tissue outcomes of single, immediately placed implants are a topic of interest. This systematic review investigates the effect of various surgical and restorative interventions on implant mid-buccal mucosal level.

Methods: An electronic search of five databases (January 1990 to December 2012) and a manual search of peer-reviewed journals for relevant articles were performed. Randomized controlled clinical trials (RCTs), prospective cohort studies, and case series with at least nine participants were included, with data on midfacial mucosal recession (MR) of immediately placed implants following various surgical and restorative interventions with a follow-up period of at least 6 months.

Results: Thirty-six studies, eight RCTs, one cohort study, and 27 case series were eligible. Six interventions were identified and reviewed: 1) palatal/lingual implant position; 2) platform-switched abutments; 3) flapless approach; 4) bone grafts to fill the gap between buccal plate and fixture; 5) connective tissue grafts; and 6) immediate provisionalization. Three studies consistently showed that palatally/lingually positioned implants had significantly less MR when using tissue-level implants. Mixed results were reported for interventions 2, 3, 5, and 6. One study was available for intervention 4 and did not show a benefit.

Conclusions: Some interventions might be adopted to reduce the amount of MR on implants with the immediate placement approach, as suggested by the included studies, with various levels of evidence. The conflicting results among studies might be a result of differences in patient and site characteristics, e.g., tissue biotype and buccal plate thickness. Therefore, the use of these interventions might be reserved for patients with moderate to high risk of esthetic complications. *J Periodontol* 2014;85:92-102.

KEY WORDS

Dental implantation; dental implants; esthetics; gingival recession; peri-implantitis; review, systematic.

Immediate implant placement (IIP) is defined as a procedure in which “an implant is placed following tooth extraction in the same surgical procedure.”¹ The compelling reason for the popularity of IIP is the patient’s desire for faster dental rehabilitation. Numerous clinical trials²⁻⁸ have proved the predictability of this approach, with the survival rate similar to that of the conventional approach, assuming prudent case selection and treatment planning. Some important anatomic factors related to the success of IIP should be assessed, including implant location,^{9,10} gingival marginal position,^{2,3,11,12} interdental papilla height,^{4-6,12} width and thickness of keratinized mucosa,^{3,7,13} gingival biotypes,^{2,3,11,14,15} crestal bone level,^{16,17} position of implant platform,¹⁸ thickness of buccal bone wall,^{9,10} dimension of the horizontal buccal gap,^{9,10} and sagittal root position.¹⁹ Careful evaluation of these factors can avoid most complications associated with IIP.

Nonetheless, untoward outcomes do happen following IIP procedures. The most commonly reported complications include dehiscence of the wound and exposure of membranes related to the guided bone regeneration procedure,²⁰ inevitable ridge resorption,^{21,22} midfacial mucosal recession (MR),^{2,3,8} loss of interdental papilla,^{6,11,23,24} and

* Department of Stomatology, Taipei Veterans General Hospital, Taipei, Taiwan.

† Private Practice, Hsinchu, Taiwan.

‡ Graduate Periodontics, Department of Periodontics and Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, MI.

a color change of peri-implant soft tissue from improper abutment material selection.²⁵ Of these complications, MR has received attention recently^{20,26} because it occurs relatively frequently and results in an unpleasing esthetic outcome.

To avoid advanced MR, various surgical and restorative protocols for IIP have been proposed and tested.^{5,27-30} For example, a flapless approach might be better for preserving soft-tissue architecture than a flap approach.³¹ Limited evidence has shown that immediately restoring an immediately placed implant could maintain the level of mucosal margin.^{5,32} However, there is a lack of reviews that critically investigate the benefit of applying currently available surgical and restorative interventions on facial mucosal level. Therefore, the aim of this systematic review is to evaluate the amount of MR for each of the available procedure modifications, in comparison to controls.

MATERIALS AND METHODS

Focused Question

The focused question addressed is: “What is the effect of each of the available surgical and restorative interventions on MR of immediately placed single implants?”

Search Strategy

A search of five electronic databases, including PubMed, Ovid (MEDLINE), EMBASE, Web of Science, and Cochrane Central, was performed for relevant studies published in the English language from January 1990 until December 2012. The search terms used were: <“immediate implant”[tiab] OR “immediate implant placement”[tiab] OR “immediate implant installation”[tiab] OR “early implant placement”[tiab] OR “immediate restoration”[tiab] OR “immediate provisionalization”[tiab] OR {“dental implants”[mh] OR “dental implantation”[mh] OR “implants”[tiab]} AND (“extraction”[tiab] OR “immediate”[tiab] OR “immediately”[tiab]) AND (“recession”[tiab] OR “esthetic”[tiab] OR “aesthetic”[tiab] OR “esthetics, dental”[mh])>, where mh represents MeSH terms and tiab represents title and/or abstract.

A manual search was also carried out in dental and implant-related journals from January 2000 until December 2012, including *Journal of Periodontology*, *Clinical Implant Dentistry and Related Research*, *International Journal of Oral and Maxillofacial Implants*, *Clinical Oral Implants Research*, *Implant Dentistry*, *International Journal of Oral and Maxillofacial Surgery*, *Journal of Oral and Maxillofacial Surgery*, *Journal of Dental Research*, *Journal of Prosthetic Dentistry*, *International Journal of Prosthodontics*, *Journal of Oral Implantology*, *Journal of Clinical Periodontology*, and *International*

Journal of Periodontics & Restorative Dentistry. The *European Journal of Oral Implantology* was searched from January 2008 until December 2012. Furthermore, a search in the references of included papers was conducted for publications that were not electronically identified. The search strategy was performed by one examiner (GL).

The included publications had to fulfill all the following criteria: 1) randomized controlled clinical trial (RCT), prospective cohort study, or case series; 2) at least nine participants; 3) studied implants located in the anterior or premolar region, with presence of adjacent teeth; 4) implants placed immediately using at least one surgical or restorative modification; 5) follow-up period of at least 6 months after restoration; and 6) midfacial MR reported as an outcome variable.

Reviews and case reports were excluded, but their bibliographies were screened for potential articles to be incorporated. Correspondence authors of potentially included papers were contacted for clarification of study methods or more detailed data sets. Potential articles were examined in full text by two reviewers (GL and HC), and their eligibility for this review was confirmed after discussion. The level of agreement between the reviewers regarding study inclusion was calculated using κ statistics.

Risk of Bias Assessment

The criteria used to assess the quality of the selected RCTs were modified from the randomized clinical trial checklist of the Cochrane Center³³ and the CONSORT statement,³⁴ which provided guidelines for the following parameters: 1) representative of general population; 2) defined inclusions/exclusions; 3) randomization methods; 4) allocation concealment method; 5) masking of the examiner; 6) intervention different only; 7) participant dropout; and 8) analysis accounting for patient losses (Table 1). Degrees of bias were categorized as low risk if all criteria were met, moderate risk when only one criterion was missing, and high risk if two or more criteria were missing. Meanwhile, the included cohort study was assessed using the Newcastle-Ottawa scale.³⁵ Each cohort study was evaluated and rated from a maximum of nine stars to a minimum of zero stars. Any study scored less than five stars was excluded. Two reviewers (GL and HC) assessed all the included articles independently.

Data Extraction

Data were extracted by two observers (GL and HC) independently from the included papers that met the criteria and were processed for analysis. If any disagreement was found, an agreement was accomplished with discussion. The parameters

Table 1.
Risk Assessment of Publication Bias for the Included RCTs

Criterion	Lindeboom et al. (2006) ⁵⁸	Chen et al. (2007) ²	Palattella et al. (2008) ⁶³	Canullo et al. (2009) ⁶⁴	De Rouck et al. (2009) ⁵	van Kesteren et al. (2010) ⁶⁶	Koh et al. (2011) ¹⁰	Pieri et al. (2011) ⁶⁹
Representative population group	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Defined inclusion/exclusion	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Randomization method	RCT	RCT	RCT	RCT	RCT	RCT	RCT	RCT
Allocation concealment method	Yes	?	Yes	Yes	?	Yes	Yes	Yes
Examiner masked	?	?	?	Yes	Yes	Yes	?	Yes
Intervention different only	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
All patients accounted for at end of study	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Analysis accounting for patient losses	No	No	NA	NA	NA	NA	NA	NA
Estimated potential risk of bias	High	High	Moderate	Low	Moderate	Low	Moderate	Low

NA = not applicable, ? = the original article did not report the related statistical result.

recorded for each study included: 1) authors' names; 2) year of publication; 3) study design; 4) sample size; 5) demographic information of the participants; 6) number of fixture placements; 7) locations of implants; and 8) follow-up period. Interventions that were available for the analysis included: 1) palatal implant position; 2) platform-switched (PS) design; 3) flapless approach; 4) use of bone grafting materials to fill the horizontal gap between implant and facial plate; 5) addition of connective tissue grafts (CTGs); and 6) immediate fixed provisionalization.

Data Analyses

The outcome was the difference in the mean MR between each intervention and its control; no comparison among interventions was intended. Due to limited sample size from only including comparative studies, publications without a control group were also included to evaluate the mean MR of each procedure modification. Considerable heterogeneities among studies, in particular study designs, various interventions, and small sample size for each procedure category, precluded a meaningful meta-analysis; therefore, the results are presented narratively. The data presented in this systematic review adhere to the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses) statement.³⁶

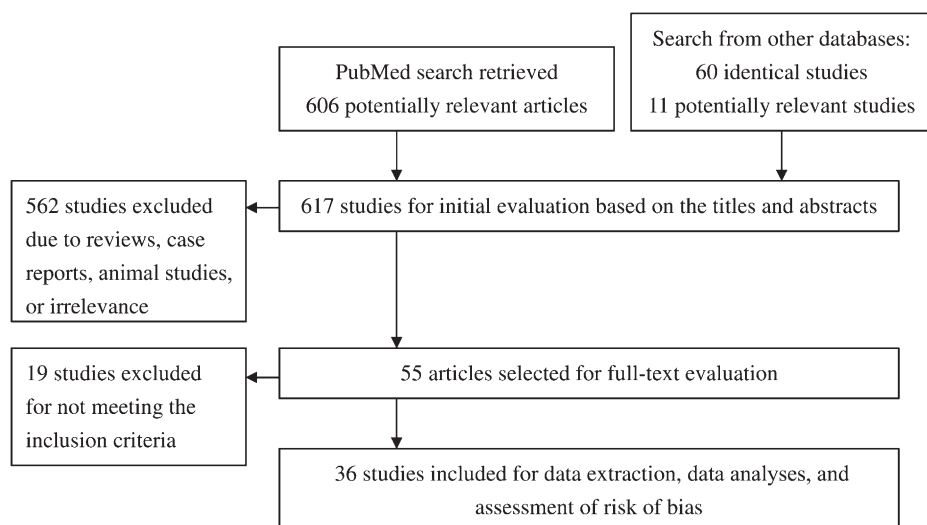
RESULTS

The screening process is shown in Figure 1. Electronic and hand searches yielded 617 articles, of which 55 were selected for full-text evaluation after screening their titles and abstracts. Nineteen articles were further excluded^{9,16,21,37-52} (reasons for exclusion are listed in Table 2). Thirty-six articles^{2-8,10,11,13,23,24,30-32,53-73} were included in this systematic review. The main features and conclusions of the included studies are summarized in Supplementary Table 1 in the online *Journal of Periodontology*.

The κ value for interreviewer agreement for potentially relevant articles was 1 (titles and abstracts) and 0.95 (full-text articles), indicating an almost perfect agreement between the two reviewers, according to the criteria by Landis and Koch.⁷⁴

Features of the Included Studies

Study design and participant features. Eight RCTs,^{2,5,10,58,63,64,66,69} one cohort study,⁴ and 27 case series^{3,6-8,11,13,23,24,30-32,53-57,59-62,65,67,68,70-73} were included. One study by Kan et al.⁷ is a long-term follow-up report of another study,⁶ and both studies used the same surgical/restorative techniques and shared the same study population. Similarly, another case series⁶⁸ is a follow-up report

**Figure 1.**

Publication selection process.

of the cohort study.⁴ Of the included studies, the age of the participants ranged from 18^{6,61} to 84⁷³ years. Smoking was not an exclusion criterion in most studies.

Extraction site. All fixtures were placed in either anterior or premolar regions of the maxilla or mandible. Sockets with considerable loss of labial/buccal bone wall were excluded in all but five studies.^{2,8,24,61,72} Of these five studies, one² included four dehiscence sites ranging in height from 6 to 10 mm; two studies did not specify the height of dehiscence, but grafting materials were used to treat the sites;^{24,61} one study⁸ included sites with facial osseous defects >3 mm subsequently treated with guided bone regeneration; and one study⁷² included 3-wall defects if the dehiscence did not exceed 3 mm. Demographic information of the implants included in this review is listed in Supplementary Table 1 in the online *Journal of Periodontology*.

Interventions and Their Effects on MR

1) Implant position. Statistical results of the effects of the six interventions on MR are summarized in Table 3. Three studies^{2,3,11} clearly defined implants as being “buccally positioned” when: 1) the distance between buccal bone wall and healing cap was ≤ 2 mm;² or 2) the buccal edge of the implant shoulder was at or buccal to a reference line drawn between the cervical buccal position of the adjacent teeth following the line of the arch.^{3,11} Three studies^{4,54,68} stated in the text that implants were placed in a more palatal/lingual position but without further information. There were significantly fewer cases having MR >1 mm when the implants were

placed palatally than buccally (in Chen et al.,² 16.67% versus 58.33%; in Evans and Chen,¹¹ 28.13% versus 80%). One study³ also showed significantly less mean marginal-level change from the baseline around palatally positioned (2.6%) than buccally positioned (6.9%) implants. It should be noted that in the three studies with statistical analyses,^{2,3,11} tissue-level implants were used; the diameter of such implants at their platform is wider than that of the implant body. In addition, tissue-level implants cannot be placed as deeply as bone-level implants. Both features make an esthetic outcome more

difficult to achieve with tissue-level implants.

2) PS design. Six studies^{23,59,64,67,69,70} used implants with the PS design, of which two were RCTs.^{64,69} One study⁶⁴ showed a mean (SD) mucosal level gain of 0.18 (0.46) mm in the PS group, compared with a loss of 0.45 (0.27) mm in the conventional connection group; the mean difference was significant ($P < 0.005$). However, another RCT⁶⁹ failed to demonstrate a beneficial effect of the PS design on the mucosal level. The other four studies^{23,59,67,70} were case series, reporting a favorable outcome using PS implants, with the mucosal margin ranging from a loss of 0.2 mm to a gain of 0.2 mm.

3) Flapless approach. In 15 studies,^{3,6,7,10,13,23,53-55,57,59,60,64,65,71} a flapless approach was adopted exclusively and showed an overall stable soft-tissue level. In four studies,^{8,24,31,32} a flapless approach was used in some participants, of which three studies^{8,24,31} allowed for comparisons of MR between the flapless and flap groups as results of secondary data analyses. Only one study³¹ showed significantly less recession in the flapless group (mean difference 0.89 mm; $P = 0.023$); the other two studies failed to support the use of the flapless approach for better mucosal level.

4) Bone grafts. Bone grafting materials were used in 19 studies,^{2,4,5,8,10,23,30,53,54,59,61,64-69,72,73} including autogenous bone grafts,^{53,54} allografts,¹⁰ mixed xenogeneic and autogenous bone grafts,⁶⁹ and xenografts.^{2,4,5,8,23,30,59,61,64-68,72,73} Criteria for use of bone grafts were gaps of >0 mm,^{4,68} >1 mm,^{54,59,64} or >2 mm.^{61,66,73} Other studies did not specify the indications. Only one study⁶⁴

Table 2.
Summary of the Excluded Articles

Reason for Exclusion	Study
No data of soft-tissue levels	Chaushu et al. (2001) ³⁷ Hui et al. (2001) ³⁸ Nemcovsky et al. (2002) ³⁹ Covani et al. (2003) ⁴⁰ Botticelli et al. (2004) ²¹ Norton (2004) ⁴² Sclar (2004) ⁴³ Vanden Bogaerde et al. (2005) ⁴⁴ Kupersmidt et al. (2007) ¹⁶ Romeo et al. (2008) ⁴⁷ Ferrus et al. (2010) ⁹ Valentini et al. (2010) ⁵⁰ Suito et al. (2011) ⁵¹ Spinato et al. (2012) ⁵²
Molar regions included	Bianchi and Sanfilippo (2004) ⁴¹ Galli et al. (2008) ⁴⁶
No investigated intervention introduced	Capelli et al. (2010) ⁴⁹ Botticelli et al. (2008) ⁴⁵ Cordaro et al. (2009) ⁴⁸

evaluated the effect of bone grafts on recession as a secondary outcome; it failed to show that the addition of bone grafts could reduce recession.

5) CTGs. Eleven included studies applied CTGs for the IIP surgery.^{3,8,30,60-62,65,67,70,72,73} Most studies did not include a control group, rendering them impossible to assess for the effect of CTGs on improving mucosal level. However, four studies^{30,67,70,72} showed coronal movement of the mucosal level after placing CTGs (if cases with graft necrosis were excluded), ranging from 0.7 to 1.7 mm. Another study⁶⁰ showed a 2.8-mm increase in keratinized mucosa width, which might be explained by coronal repositioning of the mucosal margin. Other studies^{62,65,73} showed minimal recession. Two studies^{3,8} provided comparisons of mucosal level between implants with and without receiving CTGs. One⁸ did not find a benefit of CTGs in significantly reducing the percentage of cases with >1.5-mm recession (45.5% and 25% for the CTG and control groups, respectively). The other study³ showed a marginal effect of preventing recession ($P = 0.096$), with 3.4% recession in the CTG group, measured from the baseline, and 5.6% for the same measurement in the control group.

6) Provisionalization. In 26 included papers,^{4-8,13,23,24,30-32,54,56-59,62-65,67-71,73} the implants were immediately restored with fixed temporary crowns as a part of the IIP procedure; two studies^{3,11} restored the implants immediately with removable prostheses. Two studies^{5,32} evaluated the effect of immediately placed fixed restorations on marginal level as the primary outcome and found significantly less recession, by 0.75 to 1 mm. Another study³ did a secondary data analysis and found that removable partial dentures did not significantly reduce recession.

Risk of Bias Assessment

The results of risk of bias assessment for RCTs are summarized in Table 1. Of the eight included RCTs, two^{2,58} and three^{5,10,63} were considered to have high and moderate risk of bias, respectively. The other three studies^{64,66,69} were considered to have a low risk of bias. Only one cohort study⁴ was included that scored 7 of 9 stars according to the Newcastle-Ottawa scale,³⁵ and therefore was determined to have a moderate risk of bias.

DISCUSSION

IIP might be associated with a higher incidence of MR²⁰ and subsequent poor esthetic appearance, especially for sites with thin soft tissues or wide bony defects on the buccal plate.²⁰ The underlying mechanism is not fully understood. It is possible that normal socket healing is exacerbated by additional surgical trauma introduced by placing an implant immediately.⁷⁵ Additionally, the behavior of buccal plate remodeling is highly unpredictable. It is much more difficult to determine vertical implant level in relation to the alveolar crest in IIP than in late implant placement cases. Finally, there is a tendency for surgical drills and implants to shift to the buccal side, thus increasing the risk of MR.⁷⁶ For patients with a high risk for MR, a delayed approach might be preferred. There are cases where IIP might be indicated, and at the same time, a moderate esthetic risk might be encountered. Therefore, possible procedures, including placing implants in a more palatal/lingual position, using platform-switched implants, introducing the flapless approach, using bone grafting materials to fill the horizontal gap between implant and facial plate, adding CTGs, and fabricating immediate fixed provisionalization, should be executed to minimize the amount of MR.

This study identified six surgical and restorative modifications for reducing MR, of which only palatal/lingual implant position consistently showed positive results. Buccally positioned implants led to resorption of the buccal plate and MR when tissue-level

Table 3. Summary of Statistical Results for Interventions Investigated in This Systematic Review

Surgical Intervention and Study	Follow-up (months)	Test/control (n)	MR		Level of Evidence
			Test	Control	
Palatal (test)/buccal (control) implant position Chen et al. (2007) ² Evans and Chen (2008) ¹¹ Chen et al. (2009) ³	6	18/12	16.67 (3)*	58.33 (7)*	RCT (2nd)
	18.9	32/10	28.13 (9)*	80 (8)*	CS (2nd)
	12	45/40	2.6 (6.5)†	6.9 (6.1)†	CS (2nd)
PS design (test)/flat connection (control) Canullo et al. (2009) ⁶⁴ Pieri et al. (2011) ⁶⁹	25	11/11	-0.18 (0.46)‡	0.45 (0.27)‡	RCT (FO)
	12	19/19	0.61 (0.54)‡	0.73 (0.52)‡	RCT (FO)
Flapless (test)/with flap (control) Kan et al. (2007) ⁸ Block et al. (2009) ³² Raes et al. (2011) ³¹	12	8/15	37.5 (3)§	33.3 (5)§	CS (2nd)
	24	13/13	? 0.89	? ?	CCS (2nd)
	52	11/5			CCS (2nd)
	25	14/8			RCT (2nd)
Horizontal gap filled (test)/not filled (control) Canullo et al. (2009) ⁶⁴	12	10/NA	+2.8	NA	CS (FO)
	12	11/12	45.5 (5)§	25 (3)§	CS (FO)
	12	36/49	3.4 (6.3)†	5.6 (6.8)†	CS (2nd)
	12	12/NA	1 to 2 in 21.4% of cases‡	NA	CS (2nd)
	12	17/17	Minimal	? ?	CCS (FO)
	25.8	20/NA	-0.13 (0.61)‡	NA	CS (FO)
	20.4	? 9/NA	0 0.05 mm‡	? NA	CS (FO)
	12	10/NA	(-0.07 mm excluding necrosis) 0.05 mm‡	NA	CS (FO)
	24	11/NA	(-0.25 mm excluding necrosis) -1.7 mm (0.7)‡	NA	CS (FO)
	60	31/NA	Minimal	NA	CS (2nd)
Immediate restored (test)/delayed restored (control) Block et al. (2009) ³² Chen et al. (2009) ³ De Rouck et al. (2009) ⁵	24	26/29	1 mm less MR in test than control	NA	CCS (FO)
	12	28/57	? 0.41 (0.75)‡	? 1.16 (0.66)‡	CS (2nd)
	12	24/25			RCT (FO)

2nd = Secondary data analysis, FO = first outcome, NA = not applicable, ? = not specified/unclear, CS = case series, CCS = comparative case series. Bold denotes statistical significance at $P < 0.05$. Negative value means coronal advancement of the mucosal margin.
 * Percentage MR > 1 mm (n).
 † MR (%) from baseline (SD).
 ‡ Mean MR in mm from baseline (SD).
 § Percentage MR > 1.5 mm (n).
 || The difference between test and control in mm.
 ¶ KM width change in mm.

implants were introduced.^{2,3,11} Therefore, surgical guides are recommended for IIP surgeries to prevent buccal shift of the implant position. For esthetically challenging cases, planning an implant at the cingulum position might be beneficial. Additionally, it might be advantageous to select a slightly undersized implant so that more soft- and hard-tissue volume can be preserved on the buccal side.¹⁴ Information regarding the two approaches above is scarce, and their potential advantages on soft-tissue level are yet to be confirmed.

The use of CTGs has been studied to some extent and is promising; however, because all involved studies are case series,^{3,8,30,60-62,65,67,70,72,73} a firm conclusion could not be made at this time. Of these case series, three^{30,60,72} demonstrated soft-tissue-level gain when performing IIP with CTG placement simultaneously. There is evidence that the addition of CTGs in IIP successfully converts the tissue biotype.^{23,28,30,77} However, two included studies^{3,8} with statistical analyses failed to support the use of CTGs for reducing MR. The occurrence of surgical complications might have diminished a positive effect. Graft necrosis has been reported to occur in approximately 20% of treated cases.^{67,70}

The number of studies^{3,5,8,31,32,64,69} evaluating the other four modifications is limited, and most of the results are conflicting. The PS design showed some positive effects on preserving peri-implant marginal bone.⁷⁸ It is not clear whether the mucosal level could also be preserved with this specific abutment design. Divergent outcomes^{64,69} were reported from this systematic review. The discrepancy might result from potentially confounding factors, e.g., differences of follow-up period, implant position, and soft-/hard-tissue quality/quantity, etc.

The flapless approach, being less invasive and less traumatic to vascular circulation, should be a treatment option for reducing MR. Nevertheless, of the three studies^{8,31,32} addressing this issue, only one³¹ showed a significantly smaller recession with the flapless group (mean difference: 0.89 mm; $P = 0.023$). Animal studies also showed conflicting results, reporting that the use of flapless techniques could be beneficial⁷⁹ or futile.⁸⁰ Therefore, the decision on the flap design might be determined by patient comfort, the need for access and ridge augmentation, and the experience level of the surgeon.

Use of bone grafting materials alters the modeling process of the buccal plate after tooth extraction.⁸¹ Socket augmentation with various types of bone grafts changes the bone quality⁸² and reduces the amount of ridge resorption.⁸³ The effect of bone grafts on soft-tissue alterations is not often

studied. Only one study⁶⁴ was identified in the current review, which did not show the addition of bone grafts as having a positive effect on reducing MR. Future studies should concentrate on factors that might influence the outcome, e.g., tissue biotype, size of the gap between implant and buccal plate,^{7,40,61} buccal plate thickness,⁹ and type of bone graft.

Fixed immediate restorations may reduce MR by 0.75 to 1 mm, as suggested by the two included studies.^{5,32} Temporary restorations might guide and shape peri-implant soft tissues in the esthetic zone.⁸⁴ Removable appliances may not exert the same benefit for soft-tissue levels.³ Long-term follow-up is required to confirm the short-term positive results.

Other restorative modifications to reduce MR and to enhance esthetics include the use of concave or zirconia abutments. Rompen et al.⁸⁵ suggested that the use of concave implant abutments could have more predictable soft-tissue stability in esthetic zones than convex abutments, and a vertical gain of soft-tissue level was observed in 53.7% of cases. This finding is in accordance with those of Su et al.⁸⁶ and Redemagni et al.⁶⁵ The metal hue could be avoided by use of a zirconia abutment, especially for patients with thin tissue biotype.⁸⁷⁻⁹⁰ Zirconia also showed excellent properties for attachment of epithelial cells and fibroblasts, which might contribute to long-term stability of soft-tissue level.⁹¹

Limitations of this review are the potential language bias; the number of included studies in each treatment category; overall short follow-up period of the included papers; only midfacial recession investigated; and large variations in the study designs, features of the study sites, interventions, and methods to report soft-tissue level changes among publications. To further explore this complex topic with highly clinical significance, multiple variable regression analyses might be required.

CONCLUSIONS

Risk assessment is the first step to avoid advanced MR for IIP therapy. Modifications of standard surgical and restorative procedures might be required to maximize the esthetic outcome. Six modifications have been identified from the included 36 studies. Palatal implant position is associated with less MR when using tissue-level implants. Limited evidence suggested that the PS abutment design, flapless approach, addition of CTG, and immediate fixed provisionalization might result in more favorable soft-tissue marginal level, although conflicting reports do exist. Patient and surgical site-related features might account for the inconsistent results

among publications. Therefore, the application of these modifications should be on a case-by-case basis.

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Correspondence: Dr. Hsun-Liang Chan, 1011 North University Avenue, Ann Arbor, MI 48109-1078. E-mail: hlchan@umich.edu.

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