

Behavior of peri-implantar tissue in single immediate implant placement and provisionalization in the esthetic zone: a literature review

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Abstract: The immediate implant placement and provisionalization (IIPP) is associated with vestibular recession and decrease or loss of buccal bone plate, in most case series. The search for biomaterials and clinical protocols that minimize this problem is the focus of most current research, but still with no resolution. Thus, the aim of this literature review was

to study the behavior of hard and soft peri-implantar tissue in IIPP which used biomaterials and autogenous bone as bone graft materials. The PubMed database was used as source for research, selecting 41 articles published from December 1992 to January 2017. Considering the limitations of this work, it was observed that most studies report a good implant survival rate

and a good aesthetic result in the short term. However, it could be seen recession of the buccal mucosa, reducing the thickness of the bone plate and the height of the vestibular bone crest in most articles, regardless of the graft material used.

Keywords: Dental implants, single-tooth. Immediate dental implant loading. Bone regeneration. Tooth socket.

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INTRODUCTION

It is a known fact that most anterior maxillary teeth have significantly thin buccal bone plate which might undergo considerable dimensional reduction after tooth extraction.^{1,2} As a result, keeping hard and soft tissues undamaged by means of implant treatment, so as to allow function and aesthetics to be restored, becomes one of the hardest goals.³ Additionally, the major factors determining treatment to be carried out in the aesthetic zone are: the presence of buccal bone plate⁴ and thickness of gingival biotype, both of which could be responsible for aesthetic outcomes.⁵

Animal-based studies reveal implant placement immediately after extraction is not capable of preventing the physiological process of alveolar bone remodeling.^{6,7} This finding is corroborated by human-based clinical^{8,9} and radiographic¹⁰ studies. Furthermore, implant placement into a fresh socket in the anterior region will normally lead to gap formation between implant and alveolar bone walls.⁹ This happens because rather than having a round shape similarly to the transverse portion of dental implants, anterior incisors are oval.¹¹

Buccal bone plate maintenance or reconstruction after extraction is not definitive in terms of clinical protocol nor the biomaterial of choice to be placed into the peri-implant gap.¹² A few synthetic bone substitutes, autograft, membranes, bone-inducing substances or a combination of them have been used to stimulate bone neoformation in the site of defect.^{9,13} Nevertheless, regardless of the material of choice, it is rather difficult to establish superiority of one over the others.¹⁴

In addition to that, bone graft into the gap formed between implant and alveolar bone walls has not proved effective in restraining

bone remodeling.^{5,13-20} Thus, the present literature review aims at analyzing the influence of bone graft over immediate single-tooth implant placement and provisionalization in the aesthetic zone.

LITERATURE REVIEW

The present study was carried out as an electronic search in PubMed database. Search strategy was conducted based on the following terms: “Immediate loading,” “Dental implant,” “Bone regeneration” and “Tooth socket.” A total of 40 articles published between December 1992 and January 2017 was selected.

Post-extraction buccal bone plate defect

tooth socket healing after extraction has been studied over time, with outcomes invariably revealing some degree of bone remodeling.^{6,7,9,21}

The internal socket wall is composed of lamellar bone, also known as bundle bone. Once that structure is ligament-dependent, it tends to be gradually absorbed after extraction.^{20,21} This is because blood supply deriving from periodontal ligament is cut off and the only remaining reservoir originates in the periosteum which, in turn, cannot restrain bone atrophy alone.⁹

Several authors have studied and categorized buccal bone plate defect occurring before and subsequent to post-extraction remodeling (Table 1).

As regards clinical implications for IIPP, the aforementioned categorization has become major, particularly as a method employed to determine tooth socket treatment choices and implant placement time.⁴ This precisely because it is a known fact that the greater the buccal bone plate defect, the less technical predictability there will be.^{5,25}

Table 1: Summary of articles that categorized the buccal bone plate defect.

	AU-THOR/ YEAR	SOCKET CLASSIFI- CATION	DESCRIPTION
1	Salama e Sala- ma ²² (1993)	Type I	Intact tooth socket soft and hard tissues.
		Type II	Buccal socket surface with bone defect: dehiscence or fenestration.
		Type III	Vertical defect on buccal and interproximal surfaces.
2	Elian et al. ⁴ (2007)	Type I	Buccal soft tissue and buccal plate of bone are at normal levels in relation to the cemento-enamel junction of the pre-extracted tooth and remain intact postextraction.
		Type II	Facial soft tissue is present but the buccal plate is partially missing following extraction of the tooth.
		Type III	Buccal soft tissue and buccal plate of bone are both markedly reduced after tooth extraction.
3	Rosa et al. ²³ (2010)	R1	Buccal cortical bone loss restricted to the root cervical third. Unchanged gingival margin height.
		R2	Buccal cortical bone loss affecting the root middle third. Potential increase in tissue volume; however, with unchanged gingival margin height.
		R3	Buccal cortical bone loss affecting the root apical third. Soft tissue quality affected, with potential changes in gingival margin height.
		R4	Buccal cortical bone total loss affecting beyond the root limits and jeopardizing the alveolar ridge. Local gingival quality affected and stronger probability of associated recession.
		R5	Bone loss affecting proximal bone crest. Potential for changes in either interproximal papilla or buccal gingival margin height due to loss being normally associated with jeopardized buccal cortical bone.
		R6	Bone loss affecting the palatal bone wall. Rarer defect due to thicker bone and better gingival quality in the region. This normally results in jeopardizing signs only in the root middle third.
4	El Chaar et al. ²⁴ (2016)	Degree I	Intact socket buccal bone plate revealing less than 25% bone loss.
		Degree II	Socket with fissure or dehiscence with nearly 50% buccal bone plate loss.
		Degree III	Socket with buccal bone plate loss greater than 50%.

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The IIPP technique

Since 1998, when Peter Wohrle²⁶ achieved satisfactory outcomes as a result of immediate implant placement and provisionalization in the anterior maxilla, a number of studies proposing changes in the technique have been published in the expectation of improving clinical outcomes.

In 2014, Slagter et al²⁷ published a systematic review carried out on the basis of a sample comprised of 985 implants. The authors proved that immediate implant placement and provisionalization in the aesthetic zone result in satisfactory outcomes in the short term, particularly in terms of implant survival rates and marginal bone loss.

Those findings were corroborated by another systematic review published in 2015 and conducted by Fabbro et al.³ The authors estimated survival rates for implants placed into fresh sockets, with restorations in the aesthetic zone. Based on a sample comprised of nearly 2,000 implants, the authors reported a mean survival rate of 97.60%. This implies the clinical approach is well documented and might be followed with a view to decreasing treatment time, thus keeping both clinical and aesthetic outcomes at the highest level possible.

Bone graft and behavior of peri-implant tissues

The majority of immediate implant placement cases requires increased alveolar ridge whether due to existing alveolar bone loss or in order to minimize potential remodeling processes in advance, with the latter being induced by tooth extraction.²⁸ Therefore, recent studies have made use of several means of conducting bone graft, including autogenous bone and different types of biomaterial, aimed at decreasing buccal tissue collapse – a rather common condition in tooth extraction areas to be subjected to the IIPP technique⁵ (Table 2).

Buccal bone response after implant placement is considered a decisive factor in aesthetic outcomes.³⁰ Buccal bone integrity might be a major factor in outcome stability in the medium and long-term.²⁵ However, outcomes can be affected by peri-implant biotype, tridimensional implant placement, buccal and interproximal bone crest levels,³⁴ and the distance from contact point to proximal bone crest.³⁵

IIPP with autograft

In 2016, Noelken et al³³ assessed 11 cases of immediate implant placement and provisionalization in the anterior maxilla. Three years after surgery, and by means of CBCT examination, they

found changes in the marginal bone and reported a mean increase in buccal bone plate thickness of 1.5mm. The authors had inserted autogenous bone into the gap between implant and buccal bone wall.

Similarly, in 2014, Rosa et al³¹ conducted a prospective clinical trial in which they assessed changes in gingival margin in the aesthetic zone after IIPP. The procedure was carried out in 18 patients' damaged tooth sockets with a 58-month follow-up. The authors inserted autogenous bone harvested from the maxillary tuberosity into the gap between implant and buccal bone wall. They reported finding no statistically significant recession during the assessment period. The mean value found was 0.06mm.

IIPP with allograft

In a retrospective clinical trial carried out in 2014, Ross et al¹⁷ assessed changes caused to the gingival margin in the aesthetic zone after IIPP, with allograft (Puros, Zimmer) inserted into the gap between implant and buccal bone plate. The photographs of 47 patients subjected to a 5-year follow-up were assessed. Results revealed buccal recession mean values of 0.17mm at final prosthesis placement, 0.27mm after three months, 0.30mm after one year and 0.30mm after five years. Findings reveal the majority of recession cases occurred within the first three months between implant placement plus provisionalization and final restoration.

IIPP with xenograft

In 2014, Yoshino et al¹⁶ conducted a randomized prospective trial assessing 20 patients in terms of success rates and peri-implant tissue response after IIPP was carried out in the aesthetic zone. Follow-up lasted for one year. Control group comprised 10 patients with connective tissue

Table 2: Summary of articles that analysed the behavior of hard and soft peri-implant tissues.

	AUTHOR/ YEAR	TYPE OF STUDY	GRAFT MATERIAL	SAM- PLE	METH- ODS	PARAMETERS / MEAN VALUES			FOLLOW-UP
						FGL	BCL	BABT	
1	Kan et al. ²⁹ (2011)	Prospective clinical trial	Absent	35 im- plants	Photo- graphs	-1,13	-	-	4 years post-surgery
2	Vera et al. ³⁰ (2012)	Pilot clinical trial	Absent	7 im- plants	CBCT	-	- 1,12	- 0,62	1 year post-surgery
3	Spinato et al. ¹³ (2012)	Retrospective clinical trial	Absent	23 im- plants	Photo- graphs	-0,30	-	-	1 year after final crown placement
4	Spinato et al. ¹³ (2012)	Retrospective clinical trial	Xenograft, autograft, allograft	22 im- plants	Photo- graphs	- 0,40	-	-	1 year after final crown placement
5	Yoshino et al. ¹⁶ (2014)	Prospective clinical trial	Xenograft	10 im- plants	Dental casts	- 0,70	-	-	1 year post-surgery
6	Yoshino et al. ¹⁶ (2014)	Prospective clinical trial	Xenograft with SCTG	10 im- plants	Dental casts	- 0,25	-	-	1 year post-surgery
7	Ross et al. ¹⁷ (2014)	Retrospective clinical trial	Allograft	47 im- plants	Photo- graphs	-0,30	-	-	5 years after final crown placement
8	Rosa et al. ³¹ (2014)	Prospective clinical trial	Autograft	18 im- plants	Photo- graphs	- 0,06	-	-	58 months post-surgery
9	Noelken et al. ³² (2014)	Prospective clinical trial	Autograft	33 im- plants	CBCT	-	-	1,29	2 years post-surgery
10	Lemes et al. ⁸ (2015)	Prospective clinical trial	Absent	12 im- plants	CBCT	-	- 3,31	-	6 months post-surgery
11	Morimoto et al. ¹⁰ (2015)	Retrospective clinical trial	Alloplastic	12 im- plants	CBCT	-	-0,13	- 0,26	13.3 months post-surgery
12	Noelken et al. ³³ (2016)	Prospective clinical trial	Autograft	11 im- plants	CBCT	-	-	1,5	3 years post-surgery

Caption: SCTG (subepithelial connective tissue graft); CBCT (cone-beam computed tomography); FGL (facial gingival level); BCL (bone crest level); BABT (buccal alveolar bone thickness).

graft, whereas tested group comprised 10 patients without it. Both groups had xenograft (*BioOss, Osteohealth*) carried out into the peri-implant gap. The authors reported identifying buccal gingival margin recession with a mean value of 0.70mm in the control group and of 0.25mm in the tested group. Results reveal the benefits of connective tissue graft particularly for maintenance of buccal marginal mucosa in IIPP.

IIPP with alloplastic graft

In 2015, Morimoto et al¹⁰ conducted a retrospective radiographic study describing buccal bone changes. To this end, 12 single-tooth implants placed immediately after extraction and followed by provisionalization in the anterior maxilla were assessed by means of cone-beam computed tomography (CBCT). The authors reported a vertical buccal bone resorption rate of 0.25mm, where-

as horizontal resorption rate was equal to 0.26mm, regardless of buccal bone plate thickness before surgery or the horizontal width of the gap between implant and buccal bone plate. Alloplastic graft (Calcitite, Zimmer Dental Inc., Carlsbad, CA, USA) was inserted into the gap between implant and buccal bone wall.

IIPP without graft

In 2015, Lemes et al⁸ conducted a prospective cohort study to measure changes in buccal bone crest level after IIPP in the anterior region at smiling. A total of 12 patients not subjected to graft procedures in the gap formed between implant and buccal bone wall were assessed with a 6-month follow-up and by means of computed tomographic scans. The authors reported finding decreased alveolar bone walls with a buccal bone crest resorption rate of 3.31mm.

The outcomes were corroborated by Kan et al.²⁹ In 2011, the authors published a prospective clinical trial on implant success rates and peri-implant tissue response after IIPP of 35 single-tooth implants placed in the aesthetic zone, without graft of any type into the gap between implant and buccal bone plate. After a mean follow-up period of four years, they reported a mean buccal recession rate of 1.13mm. However, the authors also confirmed that recession is a dynamic process and, therefore, might go on increasing over time.

DISCUSSION

All articles reported reveal increasing interest in the clinical approach assessed by this literature review. Despite its advantages, such as decreased treatment time, a lower number of surgical sessions and potential maintenance of both soft and hard tissues,¹ the IIPP technique must be taken cautiously whenever employed as a clinical approach for patient's treatment.

Spinato et al¹³ compared success rates and peri-implant tissue response of 45 immediate implants placed in the anterior maxilla. Follow-up lasted for 32 months. A total of 44 patients were assessed: 22 patients treated with different types of graft (autograft, xenograft and allograft) inserted into the gap between implant and buccal bone wall, whereas 22 patients received no graft. The authors reported buccal mucosa recession values ranging from 0.4mm in the grafted group to 0.3mm in the group without graft. No statically significant difference was found, regardless of the type of graft and whether it was used or not. Their conclusion highlighted that IIPP is effective in keeping soft tissues undamaged in the aesthetic zone.

Whether to proceed or not with immediate provisionalization is a decision guided by implant primary stability, which is rather difficult to reach with IIPP due to limited bone availability in the fresh socket.³⁶ A number of studies recommend minimal torque values of 15Ncm,^{32,33} 25Ncm,¹⁶ 35Ncm^{11,14,17,23} and 45Ncm,^{26,28} thus revealing lack of consensus.

A clinical trial conducted by Kan et al³⁷ in 2015 revealed the use of cone-shaped implants associated with surgical socket final drill of 0.5mm relative to implant diameter might reduce the incidence of primary instability during IIPP.

For the IIPP technique, a flapless approach is important from a surgical standpoint.^{11,17,23,26} A few studies^{32,33,37,38} support the thought of more significant bone remodeling occurring in cases of surgery with than without flap procedures. The probable cause would be blood supply cutoff to periosteal bone.¹⁴

A clinical trial compared peri-implant soft tissue morphology before and after 20 single-tooth crowns were placed in the anterior maxilla. Follow-up on implants placed into healed sockets lasted for two years. In the study conducted in 2011, Gallucci et

al³⁹ reported that even though buccal marginal mucosa levels are affected by one's peri-implant biotype, buccal bone levels, implant angulation, interproximal bone levels, depth of implant platform, and bone-implant first contact, it is only after crown placement that peri-implant soft tissue morphology presented apical displacement buccally and coronal displacement mesially and distally.

Additionally, Degidi et al³⁸ reported a series of cases subjected to the IIPP technique in the region of incisors and maxillary lateral teeth. Follow-up lasted for 18 months. A permanent intermediate component with platform-switch concept had been previously installed.⁴⁰ While assessing the tridimensional biological space around the component, the authors reported that biological balance achieved at the site could have been the ultimate reason behind favorable outcomes. In addition to that, keeping such balance unchanged might be of utmost importance to achieve success in the medium and long-term.³⁸

In 2014, Chen et al²⁵ published a systematic review in which they quantitatively estimated aesthetic outcomes of implants placed post-extraction. The authors reported immediate implant placement is associated with buccal mucosa re-

cession > 1mm in comparison to treatment onset. They suggested that in order to reduce buccal mucosa recession, strict selection criteria regarding immediate implant placement should be applied. This includes selecting sockets with undamaged buccal bone and thick gingival biotype, only.

A thick soft tissue with undamaged socket has also been recently assessed by Buser et al⁴¹ in a literature review. The authors also studied the ideal clinical conditions necessary to minimize the risk of buccal mucosa recession in cases of implant placement into a fresh socket.

While conventional protocol regarding implant placement still remains as the gold standard, immediate implant placement into fresh sockets carried out after extraction with immediate provisionalization might be a good option, provided that it be properly recommended and, thus, carried out.³

FINAL CONSIDERATIONS

Taking the limitations of the present research into account, we were able to identify buccal mucosa recession, as well as decreased bone plate and buccal bone crest thickness, regardless of graft material. This emphasizes the need for further studies in the medium and long-term.

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