Esthetic, clinical and patient-centered outcomes of immediately placed implants (Type 1) and early placed implants (Type 2): preliminary 3-month results of an ongoing randomized controlled clinical trial

Key words: dental implants, esthetics, single tooth, tooth extraction

Abstract

Aim: The objective of the study was to compare (i) esthetic, (ii) clinical and (iii) patient-centered outcomes following immediate (Type 1) and early implant placement (Type 2).

Material and methods: Thirty-eight subjects needing a single extraction (premolar to premolar) were randomly allocated to Type 1 or Type 2 implant placement. Three months following permanent crown insertion, evaluation of (i) esthetic outcomes using soft tissue positions, and the pink and white esthetic scores (PES/WES), (ii) clinical performance using probing pocket depth (PPD), modified plaque index (mPI) and modified sulcus bleeding index (mSBI) around each implant and (iii) patient satisfaction by means of a questionnaire using a visual analogue scale (VAS) was performed.

Results: Thirty-two patients completed the 3-month follow-up examination (Type 1, n = 17; Type 2, n = 15) with a 100% implant survival rate. Type 1 implants lost 0.54 ± 0.18 mm of mid-facial soft tissue height, while Type 2 implants lost 0.47 ± 0.31 mm (P > 0.05). The papillae height on the mesial and distal was reduced about 1 mm following both procedures. The PES/WES following Type 1 implant placement amounted to 13.7 ± 0.6 and 12.5 ± 0.7 in the Type 2 group (P > 0.05). PPD, mPI and mSBI were low in both groups (P > 0.05). Patient-centered outcomes failed to demonstrate any statistical difference between the two cohorts.

Conclusion: Three months following final crown delivery, there were no significant differences in esthetic, clinical and patient-centered outcomes following Type 1 and Type 2 implant placement. On the short term, one may achieve good optimal esthetic and clinical results irrespective of these two placement protocols. These results need to be confirmed on the long term.

Success of dental implant treatment of partially and edentulous patients has been documented extensively (Buser et al. 2012; Mertens et al. 2012; Ostman et al. 2012). Biological understandings of soft and hard tissue healing around implants, development of new implant surfaces and designs and development of advanced surgical techniques have allowed the extension of routine indications for implant therapy with increasing predictability and better prognosis. One of such indications is the immediate placement of implants into extraction sockets. This healing pattern was termed “Type 1” implant installation at a consensus conference (Hämmerle et al. 2004). During this conference, further implant placement protocols were defined:

- When soft tissue coverage of the extraction socket is aimed at, then a healing period of 4–8 weeks is observed before implant placement, which was defined as “Type 2” implant placement.
- When the socket is allowed to heal to have a partial bone fill of the socket, typically 12–16 weeks, this was defined as “Type 3” implant placement.
- When the extraction is fully healed after 16 weeks or more, the implant placement procedure was defined as “Type 4.”

Immediate implant placement (Type 1) has been documented as a predictable, safe and

Similarly, early placement (Type 2) following tooth extraction, typically between 4 and 8 weeks, has also been proven to be a safe and predictable technique (Hämmerle et al. 1998; Nir-Hadar et al. 1998; Nemcovsky et al. 2000; Nemcovsky & Artzi 2002; Chen et al. 2004; Buser et al. 2008a,b 2009, 2012, 2013).

In the published proceedings of the 4th ITI consensus conference [Chen & Buser 2009], immediate (Type 1) and early (Type 2) implant placement protocols presented with comparable survival rate. However, it was noted that only scarce data were available on the esthetic outcomes with post-extraction implants. More recently, the 5th ITI consensus conference [Bern, Switzerland] recommended that further research is required to document the esthetic outcomes of post-extraction implant using objective parameters [Morton et al. 2014].

On one hand, tissue recession of the facial mucosa and the papillae were reported to be more common with immediate (Type 1) implant placement protocols as compared with early implant placement (Type 2 or Type 3; Chen & Buser 2009, 2014).

On the other hand, a recent study comparing soft tissue outcomes between early and delayed implant placement has suggested that both approaches to implant placement may be successful and that early placement may provide advantages in maintaining buccal soft tissue position [Schropp et al. 2005]. Furthermore, a recent prospective randomized clinical study by van Kesteren et al. (2010) evaluated the soft tissue position comparing immediate (Type 1) and delayed (Type 4) implant placement. Interestingly, the authors reported, at 6 months after extraction, less vertical mid-facial recession for the implants placed according to the Type 1 protocol [0.05 ± 0.44 mm] when compared with those placed with Type 4 protocol [0.28 ± 0.50 mm]. However, this difference was not statistically significant. None of the patients treated with immediate implants showed recession >0.6 mm.

When comparing Type 1 and Type 2 implant placement protocols, two short-term retrospective studies [Watzek et al. 1995; Perry & Lenchewski 2004] and one prospective cohort study [Polizzi et al. 2000] reported similar survival rates for the two protocols but none reported on esthetic outcomes.

More recently, Palattella et al. (2008) showed no difference in soft tissue contours including mid-facial mucosal margin and papillae dimensions between Type 1 and Type 2 implant placement. Each procedure has its respective master clinician advocate (Wilson & Buser 2011).

Taken together, there is some conflicting evidence with regard to which procedure, immediate (Type 1) or delayed (Type 2) implant placement, is better able to maintain the buccal soft tissue position and achieve esthetic results. Moreover, a direct comparison in a prospective randomized fashion between the outcomes, especially the esthetic ones, of Type 1 and Type 2 implant placement protocols is lacking, preventing more definitive conclusion when assessing the clinical outcomes of these two procedures.

Therefore, the aim of this prospective randomized controlled clinical trial was to compare the esthetic, clinical and patient-centered outcomes following Type 1 and Type 2 implant placement protocols. While longer-term follow-up is planned, which will also include radiographic data, the present report focuses on the clinical parameters recorded at 3 months following final crown delivery.

Material and methods

Patient enrollment

Thirty-eight patients requiring tooth extraction and replacement with a dental implant were enrolled in this study. All patients were recruited at The University of Texas Health Science Center at San Antonio [UTHSCSA] Graduate Periodontics Clinic. All patients were treated by dental students, residents or faculty as primary care provider and referred to the Graduate Periodontics Clinic for screening and evaluation for possible study inclusion. Patients were included in the study if they met the following criteria:

- Eighteen years or older.
- Had adequate oral hygiene to allow for implant therapy consistent with standards of care.
- Had one tooth in either the anterior maxilla or mandible, including incisors, canines and premolars, requiring extraction leading to a single tooth gap to be replaced by means of an implant.
- Absence of interproximal bone loss at the prospective implant site.
- Following tooth extraction, all the walls of the socket were intact with no dehiscence.
- Following extraction, the surgical site allowed for immediate implant placement and implant primary stability consistent with standard care.

Patients were excluded from the study if they met the following criteria:

- Were currently smoking more than 10 cigarettes per day.
- Had a history of alcoholism or drug abuse within the past 5 years.
- Had bruxism or clenching habits.
- Had significant untreated periodontal disease or history of treated periodontitis.
- Had caries on teeth adjacent to the prospective implant site.
- Had a positive history of HIV, hepatitis B or C.
- Had a history of systemic disease that precludes standard dental implant therapy or alters daily activities to a level consistent with ASA III classification.
- Were not mentally competent.
- Were pregnant.
- Had an active localized or systemic infection.
- Had a disease/medical condition or were taking medications which affect(s) soft tissue and bony healing [history of oral/IV bisphosphonates, poorly controlled diabetes, chemotherapeutic and immunosuppressive agents or autoimmune diseases].
- Had a history consistent with high risk for infective bacterial endocarditis.
- Had a history of head and neck radiation.
- Had ongoing chemotherapy.
- Had a current hematological disorder or were on Coumadin (or similar) therapy.
- Had current steroid treatment [defined as any person who within the last 2 years has received for 2 weeks a dose equivalent to 20 mg hydrocortisone].
- Used any investigational drug or device within the 30-day period immediately prior to implant surgery.

Pre-surgical procedures and treatment allocation

All the patients were periodontally healthy. Prior to extraction, a customized radiographic film holder was fabricated for each study selected site, using a stock film holder [RINN XCP; Dentsply, York, PA, USA] and Duralay
resin (Reliance Dental Mfg Co., Worth, IL, USA). This allowed the recording of standardized periapical radiographs at the implant site throughout the study using a long cone parallel technique. Alginate impressions were made and poured in stone to obtain initial study casts. Photographs were made perpendicular to the facial surface in a 1:1 ratio (Nikon D90, Tokyo, Japan). Photographs at all subsequent visits were obtained in a similar fashion using the same camera.

The gingival biotype was determined independently by two board-certified periodontists based on the visibility or non-visibility of the periodontal probe placed in the gingival sulcus of the tooth to be extracted (De Rouck et al. 2009a; Cook et al. 2011). If agreement was not reached, a third board-certified periodontist would determine the consensus categorization.

Patients were enrolled consecutively between December 2010 and February 2012 and were randomly allocated to the immediate (Type 1) or early (Type 2) implant placement protocol by pulling out an envelope containing the concealed treatment group allocation following tooth extraction.

Surgical procedure

All the surgical procedures were performed under local anesthesia supplemented, according to patient request, with enteral or parenteral sedation. A pre-procedural 1-min 0.12% chlorhexidine rinse was given to each patient. Implants used in this study were bone level titanium implants with a modified hydrophilic acid etched and sand-blasted surface with a diameter of 3.3 or 4.1 mm and 10–14 mm in length (Straumann®, Basel, Switzerland, Bone Level Implants, SLActive) and were placed according to the manufacturer’s recommendations.

Type 1 – Immediate implant placement

If randomized to the Type 1 group, following tooth extraction integrity of the socket walls would be checked for and if intact, the surgeon would proceed with implant placement. Implant beds were prepared using successive pilot, twist and profile drills according to manufacturer recommendations. The osteotomy was placed according to previously established guidelines (Buser et al. 2004; Chen et al. 2007). In the sagittal plane (mesio-distal), the implant was placed at least 1 mm away from the adjacent root surfaces; in the vertical plane (corono-apical), the mid-buccal implant shoulder was placed approximately 3–4 mm apically to the prospective mucosal margin of the implant-supported restoration; and in the horizontal plane (bucco-lingual), the mid-buccal implant shoulder was placed at least 2 mm palatally/lingually to the mid-buccal internal border of the socket.

Following implant installation, osseous measurements were made using the following landmarks (Fig. 1) previously described by Chen et al. (2007):

- S = Implant shoulder
- BC = Top of the bone crest
- IB = Internal border of the top of crest
- EB = External border of the top of crest
- D = Base of the defect

...M, D, P and B in subscripts indicated whether the landmark was on the mesial, distal, palatal/lingual or buccal side, respectively.

The following measurements were recorded using a UNC-15 probe (G. Hartzell & Son, Concord, CA, USA) to the nearest 0.5 mm (Figs 1 and 2):

- HDD_b,p = Horizontal defect dimension defined as the distance from the shoulder of the implant (S) to the internal border of the socket (IB).
- VDH_b,p = Vertical defect height defined as the distance from the shoulder of the implant (S) to the base of the defect (D).
- SBC_b,p,M,D = The vertical distance between the shoulder of the implant (S) to the bone crest (BC) (a negative value indicated a subcrestal position of the implant shoulder).

BBW = Buccal bone width defined as the distance between the internal border (IB_b) of the socket to the external buccal border of the socket (EB_b) on the buccal aspect of the implant.

PBW = Palatal bone width defined as the distance between the internal border (IB_p) of the socket to the external buccal border of the socket (EB_b) on the palatal aspect of the implant.

Upon completion of all measurements, a 2-mm-high healing abutment (Straumann®) was placed on the implant and the gap between the implant shoulder and the internal walls of the socket was grafted using freeze-dried bone allograft (Straumann®; Straumann Allograft GC), and covered by a resorbable collagen membrane (BioGide®, Geistlich, Wollhusen, Switzerland). The flap was coronally advanced to approximate the borders of the flap and sutured back. Primary closure of the wound was not required.

Type 2 – Early implant placement

If the patients were allocated to the early implant placement protocol (Type 2), the procedure performed was based on the method described in details previously (Buser et al. 2008b). In brief, a collagen plug (Ora-plug®; Salvin, Charlotte, NC, USA) was placed into the extraction socket and sutures were placed...
over the extraction site using 4.0 or 5.0 chromic gut sutures. The site was left to heal for 4–8 weeks to allow soft tissue healing over the extraction site before the implant surgery was performed. A full-thickness muco-periosteal flap with one vertical releasing incision was elevated, and following implant placement, osseous measurements as described for the Type 1 procedure were recorded. A simultaneous guided bone regeneration procedure was performed using freeze-dried bone allograft (Straumann®, Andover, MA, USA Straumann Allograft GC) to overcontour the bone on the facial aspect of the implant. The grafted site was covered with a resorbable free closure of the flap submerging the coronal advancement and primary tension-loss was laid at the base of the flap to allow for and a horizontal periosteal releasing incision was performed using freeze-dried bone allograft (Straumann®, Andover, MA, USA Straumann Allograft GC) to overcontour the bone on the facial aspect of the implant. The grafted site was covered with a resorbable collagen membrane [BioGide®, Geistlich], and a horizontal periosteal releasing incision was laid at the base of the flap to allow for coronal advancement and primary tension-free closure of the flap submerging the grafted site.

Post-operative measures
Following the procedure, patients in both treatment groups received systemic antibiotics: amoxicillin 500 mg, three times per day for 7 days. If allergic to penicillin, patients were prescribed doxycycline 100 mg twice per day for 7 days, azithromycin 500 mg orally on the first day followed by 250 mg orally once per day on days 2 through 5, or clindamycin 150 mg four times per day for 7 days based on operator’s preference. Patients were also prescribed pain medications based on operator’s preference. Patients were instructed to rinse with 0.12% chlorhexidine twice per day for 2 weeks. Patients were also prescribed 4 mg Medrol Dosepak (methylprednisolone) when indicated.

All patients returned for post-operative assessment at 7–14 days after surgery for suture removal. Post-operative visits were also scheduled at 1 and 2 months post-implant placement.

Second-stage/uncovery surgery
Four months following implant placement, intraoral photographs and impressions were made for assessment of soft tissue dimensions, as well as the second-stage uncovering procedure. This procedure included muco-periosteal flap reflection to expose 1–2 mm of the osseous crest, and the same osseous measurement as the ones recorded at the time of implant placement were repeated. Upon completion of all measurements, a transmucosal healing abutment (Straumann®) was placed and the flaps were re-approximated with chromic gut sutures. Patients were seen 7–14 days following the second-stage procedure. If uneventful wound healing was observed, the patient was referred back to his/her primary care provider, for the initiation of the prosthetic restoration.

Follow-up visits
The protocol of this ongoing trial foresees the patient to be recalled after final crown delivery, 3, 6 and 12 months and every 6 months thereafter up to 5 years following final crown delivery. Thus, implants restoration will be clinically assessed every 6 months up to 5 years. This report is based on the 3-month evaluation following crown delivery. The study is still ongoing at the time of this report.

Esthetic outcomes
The esthetic outcomes were evaluated in two ways:

- Soft tissue dimensions were recorded using digital photograph of the casts and the Gingival Status Software (GingivalStatus 2009 v1.0.0.2; Inspektor Research Sys-

Clinical outcomes
Clinical parameters including probing pocket depth (PPD), modified plaque index (mPlI) and modified sulcus bleeding index (mSBI) were recorded using an UNC-15 probe (G. Hartzell & Son) at four sites around the implant including the mesio-buccal, mid-buccal, disto-buccal and mid-palatal/lingual sites. PPD was measured to the nearest millimeter. The

Fig. 2. Reference landmarks and osseous measurements. $S_{BCM}$ = Proximal distance from the implant shoulder to the adjacent tooth surface measured at the level of the hony crest.

$S_{BC}$ = The vertical distance between the shoulder of the implant (S) to the bone crest (BC) (a negative value indicated a subcrestal position of the implant shoulder). $Prox_M$ = Proximal distance from the implant shoulder to the adjacent tooth surface measured.
mPI and the mSBI were recorded following the guidelines developed by Mombelli et al. (1987).

These clinical parameters were recorded at each follow-up visit.

**Patient-centered outcomes**

Patients were given a questionnaire at the 3-month post-final crown delivery regarding their satisfaction in reference to the esthetic outcome, timing of implant placement, pain and swelling associated with the procedure. Their answers were recorded using a visual analogue scale ranging from 0 to 10 (VAS) labeled with “not satisfied,” “no pain,” “no swelling” at the 0 point and “completely satisfied,” “extreme pain,” “extreme swelling” at the 10 end point. Patients were also asked whether or not the implant restoration affected their ability to speak or eat.

**Sample size**

The main parameter that has been dominating the controversy between the Type 1 and Type 2 implant placement is the mid-facial soft tissue position resulting from these procedures. As such, a clinically significant treatment difference >1.0 mm in buccal soft tissue margin position in an apical coronal direction would be important to identify. Based on previous studies of soft tissue changes associated with implant therapy in which standard deviations ranged from 0.9 to 1.2 mm, we are using a standard deviation of 1.0 mm for each treatment group for sample size estimation. To detect differences between the ridge preservation and immediate placement techniques, 15 patients per treatment group were required using a two-sample comparison of means to achieve 0.80 power with α = 0.05 (Intercooled Stata 8.1, StataCorp LP, College Station, TX, USA). Given the potential for several patients to withdraw from the study protocol, we enrolled 18 patients for each treatment group in order to obtain 15 patients completing the study protocol.

**Statistical analysis**

Hard tissue data and soft tissue data were analyzed for effects of treatment (Type 1 vs. Type 2) and longitudinal changes using analysis of variance (ANOVA) for repeated measurements (Winer 1971). Some measurements were zero for all patients in both treatments; in these situations, the differences between treatments were analyzed at time of surgery using one-way ANOVA, which is equivalent to the t-test for two groups.

Pink and white esthetic scores were analyzed for effects of treatment and examiner (three examiners) using ANOVA for repeated measurements. Residual analyses confirmed that data were in reasonable accord with the assumptions underlying the ANOVA.

Patient-centered data and clinical measurements were analyzed for effect of Type using the Wilcoxon rank sum test. Differences between nonparametric and parametric are noted in the tables in the few instances when one was significant and the other was not. Percentages were compared with Fisher’s exact test.

**Ethical approval and trial registration**

This study was reviewed and approved by the Institutional Review Board of the University of Texas Health Science Center [Protocol number: HSC20100408H] and was conducted in accordance with the Helsinki Declaration, as amended in 2013. Additionally, this study was registered under www.clinicaltrials.gov (ID: NCT01623739).

**Reporting of data**

The 2010 CONSORT guidelines to report on clinical trials were followed, and a checklist is available in Supporting information.

**Results**

**Demographics**

Of the 38 patients originally enrolled to participate into the study, 32 patients completed the 3-month post-final crown delivery follow-up. Among these, 17 were in the Type 1 group and 15 were in the Type 2 group. Six patients were withdrawn from the study; this included two patients with buccal bone dehiscence and/or fenestration present at the time of extraction. In the Type 1 group, one patient with lack of implant primary stability and one patient with unacceptable proximity between the implant and the mental foramen were withdrawn. In the Type 2 group, one patient was withdrawn with a localized infection at the time of implant placement and one patient who moved out of the country after the implant placement was lost to follow-up.

The mean age of the patients in the Type 1 and Type 2 groups was 52.5 and 50.9, respectively, with no significant difference between the groups. Details of the demographic data can be found in Table 1.

**Sites treated**

The reasons for extraction included external root resorption (n = 2), deep recurrent decay on previously restored teeth (n = 14) and fracture at or below the gingival margin of the abutment tooth. Except for two teeth, all the teeth treated within the study were maxillary anterior teeth. Table 2 shows the distribution of treated sites. All the lateral incisors sites (n = 10) received a 3.3-mm-diameter implant and the remaining sites a 4.1-mm-diameter implant.

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**Fig. 3.** Screenshot of the computer in which the picture of the stone cast model against a millimeter grid was imported in the measurement software (GingivalStatus 2009 v1.0.0.2) is displayed along with the corresponding clinical picture.

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**Gingival biotype**

All sites but four (one site in the Type 1 group and three in the Type 2 group) had a thick tissue biotype.

**Implant survival and complications**

At 3-month follow-up, all implants were well integrated, resulting in a 100% implant survival for both Type 1 and Type 2 implant placement.

Complications were related to Type 2 implant placement. Two patients experienced significant swelling and bruising following surgery. The patients were advised to continue the prescribed medication regimen (antibiotics and anti-inflammatory drug). At the 2-week post-operative appointment, the swelling subsided and a normal course of healing was observed thereafter.

**Osseous tissue changes**

The measurements performed at the time of implant placement and at the second-stage/uncovering surgery are reported in Table 3.

At the time of implant placement, the osseous measurements were statistically significantly different between the two treatment groups for the horizontal defect dimension, the vertical defect dimension and the vertical distance between the shoulder of the implant to the bone crest on the buccal aspect of the implant (i.e. HDD B, VDH B, SBC B). Significantly greater horizontal and vertical defect dimensions on the facial aspect of the implant were observed in the Type 1 group.

Implants placed according to the Type 2 protocol consistently presented a facial bony dehiscence (SBC B = 1.90 ± 1.31) in relation to the implant shoulder at the time of placement, whereas their Type 1 counterparts were always slightly subcrestal (SBC B = −0.82 ± 0.21). At the time of re-entry, all the osseous measurements were similar in both treatment groups with no significant differences between them.

**Soft tissue changes**

When assessing the soft tissue level including the mid-facial mucosal margin and the height of the mesial and distal papillae (Table 4), at no time point was there a significant difference between the two treatment groups. Along the same lines, the soft tissue changes between baseline, that is, prior to extraction, and 3 months post-crown delivery did not demonstrate any significant differences between the two groups.

A mean mid-facial recession of about 0.5 mm was observed at the 3-month follow-up visit irrespective of the treatment received (Type 1: 0.54 ± 0.18 mm vs. Type 2: 0.47 ± 0.31 mm, P = 0.85). This primary outcome measure for the study shows no significant difference between Type 1 and Type 2 implant placement at 3 months following crown delivery.

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**Table 1. Patient demographics**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No. of patients</th>
<th>Males</th>
<th>Females</th>
<th>Mean age (years)</th>
<th>Standard deviation</th>
<th>Range (years)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>17</td>
<td>9</td>
<td>8</td>
<td>52.5</td>
<td>15.6</td>
<td>27-74</td>
<td>ns, 0.76</td>
</tr>
<tr>
<td>Type 2</td>
<td>15</td>
<td>9</td>
<td>6</td>
<td>50.9</td>
<td>14.6</td>
<td>26-67</td>
<td></td>
</tr>
</tbody>
</table>

ns: Not statistically significant (P > 0.05), confirmed with Wilcoxon rank sum test.

**Table 2. Distribution of treated sites**

<table>
<thead>
<tr>
<th>Maxilla</th>
<th>Tooth no.</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>21</th>
<th>22</th>
<th>23</th>
<th>24</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 3. Osseous measurements recorded at the time of implant placement and at the second-stage surgery**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Time</th>
<th>Measurement</th>
<th>Type 1 Mean ± SE</th>
<th>Type 2 Mean ± SE</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDD B</td>
<td>Stage 2</td>
<td>Implant surgery</td>
<td>2.79 ± 0.15</td>
<td>1.47 ± 0.27</td>
<td>0.0001*</td>
</tr>
<tr>
<td>HDD P</td>
<td>Stage 2</td>
<td>Implant surgery</td>
<td>0.68 ± 0.27</td>
<td>0.40 ± 0.25</td>
<td>ns</td>
</tr>
<tr>
<td>VDH B</td>
<td>Stage 2</td>
<td>Implant surgery</td>
<td>5.08 ± 0.76</td>
<td>4.20 ± 0.91</td>
<td>0.003*</td>
</tr>
<tr>
<td>VDH P</td>
<td>Stage 2</td>
<td>Implant surgery</td>
<td>2.35 ± 0.90</td>
<td>0.70 ± 0.42</td>
<td>0.11, ns</td>
</tr>
<tr>
<td>SBC B</td>
<td>Stage 2</td>
<td>Implant surgery</td>
<td>−0.82 ± 0.21</td>
<td>1.90 ± 1.31</td>
<td>0.06†</td>
</tr>
<tr>
<td>SBC P</td>
<td>Stage 2</td>
<td>Implant surgery</td>
<td>−0.41 ± 0.31</td>
<td>−0.60 ± 0.25</td>
<td>0.65, ns</td>
</tr>
<tr>
<td>SBC M</td>
<td>Stage 2</td>
<td>Implant surgery</td>
<td>−2.56 ± 0.27</td>
<td>−2.13 ± 0.22</td>
<td>0.24, ns</td>
</tr>
<tr>
<td>SBC D</td>
<td>Stage 2</td>
<td>Implant surgery</td>
<td>−1.68 ± 0.29</td>
<td>−1.87 ± 0.19</td>
<td>0.60, ns</td>
</tr>
<tr>
<td>BBW</td>
<td>Stage 2</td>
<td>Implant surgery</td>
<td>2.53 ± 0.12</td>
<td>0.90 ± 0.17</td>
<td>0.53, ns</td>
</tr>
<tr>
<td>PBW</td>
<td>Stage 2</td>
<td>Implant surgery</td>
<td>1.23 ± 0.17</td>
<td>0.20 ± 0.28</td>
<td>0.71, ns</td>
</tr>
<tr>
<td>PROX M</td>
<td>Stage 2</td>
<td>Implant surgery</td>
<td>1.15 ± 0.16</td>
<td>1.07 ± 0.15</td>
<td>0.72, ns</td>
</tr>
<tr>
<td>PROX D</td>
<td>Stage 2</td>
<td>Implant surgery</td>
<td>2.65 ± 0.16</td>
<td>2.77 ± 0.13</td>
<td>0.58, ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.62 ± 0.14</td>
<td>2.83 ± 0.13</td>
<td>0.26, ns</td>
</tr>
</tbody>
</table>

HDD = Horizontal defect dimension defined as the distance from the shoulder of the implant to the internal border of the socket. VDH = Vertical defect height defined as the distance from the shoulder of the implant to the base of the defect. SBC = Vertical distance between the shoulder of the implant to the bone crest (a negative value indicated a subcrestal position of the implant shoulder). BBW = Buccal bone width defined as the distance between the internal border (Bb) of the socket to the external buccal border of the socket (Eb) on the buccal aspect of the implant. PBW = Palatal bone width defined as the distance between the internal border (Bb) of the socket to the external buccal border of the socket (Eb) on the palatal aspect of the implant. PROX = Proximal distance from the implant shoulder to the adjacent tooth surface measured at the level of the bony crest. B, P, M and D indicate the buccal, palatal, mesial and distal sites, respectively.

ns: Not statistically significant (P > 0.05), confirmed with Wilcoxon rank sum test.

*Statistically significant (P < 0.05), confirmed with Wilcoxon rank sum test.

†Not statistically significant (P > 0.05) with t-test, but became significant with Wilcoxon rank sum test (P = 0.03).
Table 4. Soft tissue levels at baseline and 3 months post-crown delivery

<table>
<thead>
<tr>
<th>Variable</th>
<th>Time</th>
<th>Soft tissue level (mm)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type 1 Mean ± SE</td>
<td>Type 2 Mean ± SE</td>
<td>P-value</td>
</tr>
<tr>
<td>Mid-facial</td>
<td>Prior to extraction</td>
<td>8.79 ± 0.57</td>
<td>9.12 ± 0.27</td>
</tr>
<tr>
<td></td>
<td>3 months post-loading</td>
<td>9.34 ± 0.47</td>
<td>9.59 ± 0.46</td>
</tr>
<tr>
<td></td>
<td>Difference*</td>
<td>0.54 ± 0.18</td>
<td>0.47 ± 0.31</td>
</tr>
<tr>
<td>Papilla mesial</td>
<td>Prior to extraction</td>
<td>6.08 ± 0.32</td>
<td>6.58 ± 0.42</td>
</tr>
<tr>
<td></td>
<td>3 months post-loading</td>
<td>7.11 ± 0.34</td>
<td>7.89 ± 0.43</td>
</tr>
<tr>
<td></td>
<td>Difference*</td>
<td>1.03 ± 0.20</td>
<td>1.31 ± 0.31</td>
</tr>
<tr>
<td>Papilla distal</td>
<td>Prior to extraction</td>
<td>5.97 ± 0.30</td>
<td>6.31 ± 0.27</td>
</tr>
<tr>
<td></td>
<td>3 months post-loading</td>
<td>6.81 ± 0.37</td>
<td>7.61 ± 0.37</td>
</tr>
<tr>
<td></td>
<td>Difference*</td>
<td>0.84 ± 0.23</td>
<td>1.29 ± 0.30</td>
</tr>
</tbody>
</table>

ns: Not statistically significant (P > 0.05), confirmed with Wilcoxon rank sum test. *Three months post-loading minus baseline (a positive value indicates a soft tissue recession).

Fig. 4. Prevalence distribution of mid-facial soft tissue changes in the two treatment groups. A negative value for mid-facial soft tissue change indicates a net tissue gain, whereas a positive value indicates a true recession.

The extent and prevalence distribution of mid-facial mucosal recession is depicted in Fig. 4. Based on this figure, 47.1% of the sites treated with immediate implant placement (Type 1) experienced ≤0.5 mm of recession or an actual soft tissue gain. The corresponding value for sites in the Type 2 group was 53.3%.

Sites experiencing 0.6–1.0, 1.1–2.0 and >2 mm of recessions in the Type 1 and the Type 2 groups amounted to 29.4% and 20.0%, 24.5% and 20%, 0% and 6.7%, respectively.

**Pink and white esthetic scores**
The esthetic outcome of the final restoration was evaluated at the 3-month follow-up visit using the PES/WES criteria previously defined by Belser et al. (2009).

Neither PES individually or WES individually, nor the PES/WES taken together were significantly different when comparing the outcome following Type 1 and Type 2 implant placement (Table 5).

Moreover, if the clinical acceptable threshold for the PES was set at 6, the percentage of clinically acceptable cases was 88.2 ± 8.1% for the Type 1 group and 60 ± 13% for the Type 2 group. Taking the same threshold for the WES, the percentage of clinically acceptable cases were 58.8 ± 12.3% and 66.7 ± 12.6% for the Type 1 and Type 2 groups, respectively. None of these differences were statistically significant (P > 0.05).

**Clinical outcomes**
At the 3-month follow-up examination, no statistically significant differences were observed for any of the clinical parameters recorded including PPD, modified plaque index and modified sulcus bleeding index between the two treatment groups (Table 6).

**Patient-centered outcomes**
Patients in both groups were overall very satisfied with regard to timing of implant placement and the overall appearance of their final restoration. The degree of satisfaction was not significantly different between the two groups. Similarly, the level of pain and swelling was rated as low in both groups with no significant differences. A similar fraction of the patients had their ability to speak and to eat affected by the procedure irrespective of the treatment procedure (Table 7).

**Discussion**
The goal of this study was to determine whether there was any difference in esthetic outcomes following immediate dental implant placement (Type 1) in comparison with implants placed 4–8 weeks after extraction (Type 2). Immediate implant placement was first reported by Schulte and Heimke in the 1970s (Schulte & Heimke 1976), and today immediate implants have become a common procedure.

Immediate placement offers various advantages over the conventional delayed placement such as the requirement for a single surgical procedure and reduced overall treatment time (Chen et al. 2009).

On the other hand, disadvantages of immediate placement include the inability to predict facial bone remodeling which may lead to mid-buccal recession and compromise esthetic outcomes (Chen et al. 2004, 2009; Kan et al. 2007; Evans & Chen 2008). A recent systematic review (Chen & Buser 2014) reported that Type 2 implant placement was associated with less mucosal mid-facial recession as compared to Type 1 implant placement. These results summarized the findings looking at comparative studies (looking at Type 1 and Type 2 implant placement) and non-comparative studies (looking either at Type 1 or Type 2). Taking a closer look, only three comparative studies were identified: two case cohort studies (Juodzbalys & Wang 2007; Miyamoto & Obama 2011) and one randomized controlled trial (Palattella et al. 2008). The outcome reported by these studies consistently showed no significant difference in mid-facial mucosal margin when comparing the two implant placement protocols.

The vast majority of the studies assessing change in mid-facial mucosal level were case series studies reporting on Type 1 Implant placement. The authors noted that they were heterogenous and showed a wide variation in results. The average mid-facial mucosal change reported varied from 0.23 mm of coronal gain to 0.9 mm of recession following Type 1 implant placement. In comparison, the mean recession reported in case series using Type 2 implant placement protocol ranged from 0.09 to 0.3 mm. While variation in mid-facial mucosal position was greater following Type 1 implant placement, in many instances this change following
Table 5. Average PES/WES by implant placement protocol controlling for examiner in a two-way ANOVA

<table>
<thead>
<tr>
<th>Score</th>
<th>Variable</th>
<th>Type 1 Mean ± SE</th>
<th>Type 2 Mean ± SE</th>
<th>Significance P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PES</td>
<td>Mesial papillary</td>
<td>1.43 ± 0.16</td>
<td>1.29 ± 0.17</td>
<td>0.55, ns*</td>
</tr>
<tr>
<td></td>
<td>Distal papillary</td>
<td>1.24 ± 0.14</td>
<td>0.98 ± 0.15</td>
<td>0.23, ns*</td>
</tr>
<tr>
<td></td>
<td>Facial curvature</td>
<td>1.37 ± 0.14</td>
<td>1.22 ± 0.15</td>
<td>0.47, ns*</td>
</tr>
<tr>
<td></td>
<td>Facial recession</td>
<td>1.75 ± 0.10</td>
<td>1.44 ± 0.11</td>
<td>0.049†</td>
</tr>
<tr>
<td></td>
<td>Convex</td>
<td>1.18 ± 0.11</td>
<td>1.16 ± 0.12</td>
<td>0.90, ns*</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>6.96 ± 0.36</td>
<td>6.07 ± 0.38</td>
<td>0.10, ns*</td>
</tr>
<tr>
<td></td>
<td>Acceptable (%)††</td>
<td>88.2 ± 8.1</td>
<td>60.0 ± 13.1</td>
<td>0.11, ns††</td>
</tr>
<tr>
<td>WES</td>
<td>Tooth form</td>
<td>1.55 ± 0.15</td>
<td>1.31 ± 0.15</td>
<td>0.27, ns*</td>
</tr>
<tr>
<td></td>
<td>Outline</td>
<td>1.22 ± 0.12</td>
<td>1.02 ± 0.12</td>
<td>0.27, ns*</td>
</tr>
<tr>
<td></td>
<td>Color</td>
<td>1.06 ± 0.11</td>
<td>1.11 ± 0.12</td>
<td>0.75, ns*</td>
</tr>
<tr>
<td></td>
<td>Surface texture</td>
<td>1.53 ± 0.08</td>
<td>1.62 ± 0.09</td>
<td>0.44, ns*</td>
</tr>
<tr>
<td></td>
<td>Translucency</td>
<td>1.35 ± 0.11</td>
<td>1.40 ± 0.11</td>
<td>0.76, ns*</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>6.71 ± 0.43</td>
<td>6.44 ± 0.46</td>
<td>0.68, ns*</td>
</tr>
<tr>
<td></td>
<td>Acceptable (%)††</td>
<td>58.8 ± 12.3</td>
<td>66.7 ± 12.6</td>
<td>0.73, ns†‡</td>
</tr>
<tr>
<td>Combined</td>
<td>Total</td>
<td>13.67 ± 0.61</td>
<td>12.51 ± 0.65</td>
<td>0.21, ns*</td>
</tr>
<tr>
<td></td>
<td>PES + WES ≥ 12 (%)**</td>
<td>88.2 ± 7.8</td>
<td>53.3 ± 12.9</td>
<td>0.049††</td>
</tr>
<tr>
<td></td>
<td>PES ≥ 6 and WES ≥ 6 (%)††</td>
<td>47.1 ± 12.5</td>
<td>46.7 ± 13.3</td>
<td>0.99, ns††</td>
</tr>
</tbody>
</table>

PES/WES, pink and white esthetic scores. ns: Not statistically significant (P > 0.05).
*Using ANOVA and confirmed with Wilcoxon rank sum test. Wilcoxon rank sum test was performed on the average score of the three examiners.
†Statistically significant (P < 0.05) with ANOVA, but became not statistically significant (P > 0.10) with Wilcoxon rank sum test. Wilcoxon rank sum test was performed on the average score of the three examiners.
‡Proportion of acceptable esthetic cases as defined by three examiner average PES ≥ 6 or WES ≥ 6.
§Using Fisher’s exact test.
**Proportion of acceptable esthetic cases as defined by examiner average PES + WES ≥ 12.
††Statistically significant (P < 0.05) using Fisher’s exact test.
‡‡Proportion of acceptable esthetic cases as defined by examiner average PES ≥ 6 and WES ≥ 6.

Table 6. Clinical parameters at the 3-month follow-up visit

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement</th>
<th>Type 1 Mean ± SE</th>
<th>Type 2 Mean ± SE</th>
<th>Significance P-value t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPD-M</td>
<td></td>
<td>2.88 ± 0.21</td>
<td>2.87 ± 0.22</td>
<td>0.96, ns</td>
</tr>
<tr>
<td>PPD-B</td>
<td></td>
<td>2.59 ± 0.15</td>
<td>2.53 ± 0.19</td>
<td>0.82, ns</td>
</tr>
<tr>
<td>PPD-D</td>
<td></td>
<td>2.82 ± 0.23</td>
<td>3.13 ± 0.19</td>
<td>0.32, ns</td>
</tr>
<tr>
<td>PPD-P</td>
<td></td>
<td>3.06 ± 0.18</td>
<td>2.93 ± 0.18</td>
<td>0.63, ns</td>
</tr>
<tr>
<td>mSBI-M</td>
<td></td>
<td>0.18 ± 0.10</td>
<td>0</td>
<td>0.08, ns</td>
</tr>
<tr>
<td>mSBI-B</td>
<td></td>
<td>0.06 ± 0.06</td>
<td>0</td>
<td>0.36, ns</td>
</tr>
<tr>
<td>mSBI-D</td>
<td></td>
<td>0.12 ± 0.08</td>
<td>0.07 ± 0.07</td>
<td>0.63, ns</td>
</tr>
<tr>
<td>mSBI-P</td>
<td></td>
<td>0.18 ± 0.10</td>
<td>0</td>
<td>0.08, ns</td>
</tr>
<tr>
<td>mPI-M</td>
<td></td>
<td>0.18 ± 0.10</td>
<td>0.20 ± 0.12</td>
<td>0.89, ns</td>
</tr>
<tr>
<td>mPI-B</td>
<td></td>
<td>0.12 ± 0.08</td>
<td>0</td>
<td>0.16, ns</td>
</tr>
<tr>
<td>mPI-D</td>
<td></td>
<td>0.18 ± 0.10</td>
<td>0.27 ± 0.15</td>
<td>0.61, ns</td>
</tr>
<tr>
<td>mPI-P</td>
<td></td>
<td>0.24 ± 0.11</td>
<td>0</td>
<td>0.04*</td>
</tr>
</tbody>
</table>

PDD = Probing pocket depth; mSBI = Modified sulcus bleeding index; mPI = Modified plaque index; M, B, D and P indicate the mesial, buccal, distal and palatal sites, respectively. ns: Not statistically significant (P > 0.05), confirmed with the Wilcoxon rank sum test.
*Statistically significant (P < 0.05), confirmed with the Wilcoxon rank sum test.

Type 1 protocol compared favorably to the results observed following Type 2 implant placement. It should also be mentioned that most of the data pertaining to Type 2 implant placement derived from one particular group of investigators [Buser et al. 2008a, b, 2009, 2011, 2013] which may limit the generalizability of this technique.

Another interesting point noted in this systematic review is that among the studies reporting on immediate implant placement published prior to or during the year 2008, only 20% [one of five studies, Canullo & Rasperini 2007] reported mean recession values within the range of the one reported in the case series following the Type 2 protocol. For cases series on Type 1 published after 2009, 62.5% [five studies of eight, Covani et al. 2004; Tortamano et al. 2010; Brown & Payne 2011; Chung et al. 2011; Kan et al. 2011, Tsuda et al. 2011] of them fall within that range. It may be hypothesized that experience and knowledge gained from previous research and clinical practice have improved the outcome of Type 1 implant placement as measured by the mid-facial mucosal change.

One strength of the available evidence for Type 2 implant placement and corollary a limitation for Type 1 implant placement is that the follow-up time reported by Buser et al. [2013], a mean of 7 years, outweighs the documentation available for Type 1. The majority of Type 1 studies had a follow-up of 1 year and only a few of ≥5 years (Kan et al. 2011; Malchiodi et al. 2013).

In the present study, following Type 1 implant placement, a mean mid-buccal mucosal recession of 0.54 ± 0.18 mm at 3 months post-final crown delivery was measured, while the corresponding value for implants placed according to the Type 2 protocol amounted to 0.47 ± 0.31 mm. Similar values for recession following Type 1 or Type 2 procedures have been reported by other studies [De Rouck et al. 2008a, 2009b, Palattella et al. 2008; Kan et al. 2011, Miyamoto & Obama 2011; Malchiodi et al. 2013].

Conversely, few studies have reported less recession than the present study. van Kesteren et al. [2010] showed that immediate implants experienced a mid-buccal mucosal recession of 0.13 ± 0.34 mm over the first 3 months post-crown insertion. De Bruyn et al. [2013] in a multicenter trial comparing the outcomes of Type 1 and Type 4 implants placement resulted in a mean recession of 0.23 ± 0.87 mm in the Type 1 group 3 years after final crown delivery. Following Type 2 implant placement, Cosyn & De Rouck [2009] and Buser et al. [2011] showed a mean recession of 0.3 ± 1.2 mm after a mean function time of 21 months and 0.18 ± 0.58 mm at 3 year, respectively.

These differences may be due to distinct study methodologies. van Kesteren et al. [2010] performed the measurements of the soft tissue with the transmucosal healing abutment in place while the implants had not been loaded yet. The lack of prosthetic reconstruction may have favorably influenced the level of the soft tissue margin. As compared to the three other studies [Cosyn & De Rouck 2009; Buser et al. 2011; De Bruyn et al. 2013], a common difference in the present study is represented by the fact that all implants were submitted to a full-thickness
flap reflection to enable hard tissue measurements at the time of implant placement and at the stage 2 uncovering. As classic periodontal studies have shown that a mean crestal bone loss ranging from 0.23 to 0.62 mm can result following full-thickness flap reflection (Kohler & Ramfjord 1960; Tavtigian 1970; Wood et al. 1972), the cumulative surgical procedures performed in the present study may have accounted for more crestal bone resorption and consequently for slightly greater amount of soft tissue recession as compared to the other studies mentioned above (Cosyn & De Rouck 2009; Buser et al. 2011; De Bruyn et al. 2013) in which no flap or a one-time full-thickness flap was raised.

Nonetheless, our findings suggest that there are minimal differences in the mid-buccal soft tissue levels following immediate (Type 1) or early implant placement (Type 2), which are also in accordance with other controlled trial assessing the outcomes of these two implant placement protocols [Juodzbalys & Wang 2007; Palattella et al. 2008; Miyamoto & Obama 2011].

Mesial papillae lost on average 1.03 ± 0.20 mm in the Type 1 group and 1.31 ± 0.31 mm in the Type 2 group, while the distal papillae experienced 0.84 ± 0.23 and 1.29 ± 0.30 mm in respective treatment groups. This interproximal papilla loss at both mesial and distal sites of implant-retained single tooth restoration is similar to what other authors have reported [Kan et al. 2003; De Rouck et al. 2008a; Cosyn & De Rouck 2009] and maybe due to papilla reflection during surgery [Cosyn et al. 2012a]. PES/WES [Belser et al. 2009] were also examined in this study to help evaluate esthetics. This score combines the assessment of the soft tissues as well as the implant-supported crown to provide a comprehensive esthetic evaluation. The results indicate that there was no significant difference between the two implant groups with regard to the pink esthetic score. With respect to the PES, the level of mid-buccal mucosal margin was given the highest scores for both groups, which may be due to the minimal amount of soft tissue recession that was experienced in both groups at the 3-month follow-up. When comparing the overall mean PES between the groups, no statistical difference was found.

One of the five PES variables, the composite variable, which included the soft tissue convexity and tissue color and texture was not statistically different between the two groups. This may be surprising because the Type 2 implant placement allows for ridge contouring beyond the original “pre-extraction” bony envelope as opposed to the Type 1 implant placement protocol which only allows for grafting the gap between the extraction socket and the implant, that is, within the confines of the existing alveolar ridge. Therefore, it was expected that the convexity or “root” prominence on the facial sites of the implants placed according to the Type 2 protocol would be better maintained (Buser et al. 2008a,b). This discrepancy may be due to the difference in biomaterial used for the GBR procedure. The original ridge contour augmentation described by Buser et al. (2008b) recommended the use of autogenous bone and a bovine bone mineral with a low substitution rate (Schlegel et al. 2003; Artzi et al. 2004) [BioOss®; Geistlich] as a filler. In contrast, the current study utilized FDBA [Straumann Allograft GC; Straumann] to augment the contour of the ridge. The difference in substitution rates and resorption patterns between these two biomaterials may explain the lack of difference in the ability to maintain the ridge contour between the two groups in the present study [Taylor et al. 2002; Schlegel et al. 2003; Artzi et al. 2004].

When comparing the overall mean white esthetic scores between the groups, the Type 1 group yielded a score of 6.71 ± 0.43 and the Type 2 group 6.44 ± 0.46 with no statistically significant difference. One of the lowest score for both groups was associated with the color of the implant crown, which has also been previously reported and described [Raes et al. 2011; Eghbali et al. 2012]. This parameter, which is based upon the color match to the contralateral tooth, is mainly dependent upon the quality and experience of the dentist taking the shade and the dental technician fabricating the crown. Optimal color matching, which would translate into a high WES for color, may be difficult to achieve as it relies on multiple aspects such as the specific ceramic used and the thickness required to achieve adequate esthetics and the method used for shade determination [Li & Wang 2007]. Moreover, despite the use of shade guide as a standard method to determine the color of the prospective restoration, this method remains highly subjective and is reflected in our low WES for color [Miller 1987].

The percentage of cases with an acceptable esthetic outcome as defined by Belser et al. [2009] as a PES + WES of ≥12 was significantly higher for the implants placed according to the Type 1 protocol. This definition by Belser et al. may present a limitation as a poor score in either one of the parameters (PES or WES) could be compensated for by the other. For example, if a crown had a WES of 3 and a PES of 9, it would still be considered as clinically acceptable.

Therefore, if the condition to be fulfilled for an esthetic crown was redefined as having both a PES ≥6 and a WES ≥6, no statistically significant difference would be observed between the two treatment groups (Type 1: 47.1 ± 12.5% vs. Type 2: 46.7 ± 13.3%). This suggests that having a combined score PES + WES may inflate the number of clinically acceptable cases from an aesthetic standpoint.

Our results are similar to those found by Cosyn et al. [2012b] who compared esthetic outcomes using the PES/WES following Type 2 vs. Type 4 implant placement. The authors reported no significant differences for any of the criteria between the two treatment modalities. They also showed that 26% of cases when graded using the PES/WES criteria were esthetic failures, while 74% of the cases demonstrated acceptable or close to perfect esthetic results. Conversely, our results differ from the results reported by Belser et al. [2009] and Buser et al. [2009, 2011].
who reported lower failure (PES/WES < 12) rate of ≤5%. One possible explanation is based on the difference in the timing of the esthetic outcome evaluation. In the present study, the PES/WES assessment was performed at 3 months following final crown delivery, while in the aforementioned studies, the esthetic evaluation took place between 1 and 4 years following functional loading. As Lai et al. [2008] demonstrated that the PES index significantly improved over time (between the 10–16 weeks and 6-month timeline), the difference in follow-up may account for the discrepancy observed between these studies.

The decreased PES/WES index observed may also be related to difference in patient selection. Our patients included those with higher esthetic risk compared to those included in previous studies. In fact, Buser et al. [2009] only included patients with non-restored adjacent teeth, while many patients in our study had full coverage restorations on the adjacent teeth made at different time points. Consequently, in presence of two non-matching WES restorations, the implant-supported restoration evaluated in our study could not match both adjacent teeth, which led to a decreased WES. In the current study, an unacceptable WES defined as a score <6 was seen in 25.5% of cases in the Type 1 group and 31.1% in the Type 2 group. Although our esthetic failure rates were high, they do fall within the range of failure rates that have been previously published and neither group had a statistically significant advantage over the other with regard to evaluation of the PES/WES (Meiindert et al. 2007; Lai et al. 2008; Cosyn & De Rouck 2009; Cosyn et al. 2012b).

One limitation in the study design was the lack of standardized procedures for the fabrication of the implant-supported restoration, as multiple restorative dentists and dental laboratories were involved. This may have confounded the results obtained, especially the WES. However, this is a more realistic representation of the clinical setting in which practitioners work, that is, with different dental laboratory technicians, and may make the data more generalizable. Despite the esthetic failure rate reported based on the PES/WES, it is important to remember patient perception of their implant crown esthetics frequently differs from the dental professional perspective (Kokich et al. 1999). Based on the patient questionnaire, a high satisfaction rate with regard to implant crown esthetic was reported. Implants placed according to the Type 1 protocol were rated with a mean VAS score of 9.6 ± 0.4, while the ones placed following the Type 2 guidelines scored 9.3 ± 0.4 out of 10, with no significant difference between the two groups. The scores from both groups are in accordance with another study evaluating patient satisfaction with regard to esthetic outcomes [Suphanantachat et al. 2012]. When the authors assessed patient satisfaction in relation to timing of implant placement, patients in both treatment groups reported that they were satisfied (VAS score of ≥9) of 10. This is an important piece of information because it indicates that patients, especially those allocated to the Type 2 treatment group, did not seem to think that the timing between extraction and implant placement was unsatisfactory. However, it has to be conceded that the results may have been different if one patient could have experienced both placement protocols.

When comparing the amount of swelling and pain associated with the implant placement, again no statistically significant differences between the groups were noted and both were considered to have minimal pain and minimal swelling. It can be concluded that the patients in the present study were very satisfied with the outcome of their implant procedure irrespective of the treatment modality. This compares favorably with patient-centered outcomes reported by Pjetursson et al. [2005] in which over a 10-year follow-up period, more than 90% of the 104 patients receiving dental implant restorations of were completely satisfied with their implant restoration from both a functional and esthetic view.

Clinical parameters including probing depths, presence of plaque around the implant restorations and bleeding on probing around implants indicated healthy peri-implant tissue around all implants, irrespective of the placement protocol. However, these represent only a short-term snapshot of the peri-implant clinical conditions and further evaluation is warranted.

In conclusion, this clinical study showed that immediate (Type 1) and early (Type 2) implant placement demonstrate similar results in terms of esthetic outcomes, mid-buccal and interproximal soft tissue recession, clinical parameters and patient perceptions 3 months after crown insertion. To confirm these positive initial results, long-term follow-up of the present patient population is needed and will be included in subsequent manuscripts as the study progresses.

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Conflict of interest
All other authors have no conflict of interest to report.

References


Supporting Information

Additional Supporting Information may be found in the online version of this article:

**Appendix S1.** CONSORT 2010 checklist of information to include when reporting a randomised trial.