Soft tissues healing at immediate transmucosal implants placed into molar extraction sites associated with buccal self-contained dehiscences.

A 12-month controlled clinical trial

Introduction

A reduced number of surgical interventions, a shorter treatment time, an ideal three-dimensional implant placement and an optimal outcome of soft tissue esthetics have been listed as potential advantages of immediate implant placement into fresh extraction sockets (Chen et al. 2004). On the other hand, the site morphology, the presence of active periapical pathology, the absence of keratinized tissue or a thin tissue biotype and the lack of complete soft tissue closure over the extraction socket were reported to adversely affect the outcomes of immediate implant placement (Hämmerle et al. 2004).

Outcomes from experimental studies indicated that buccal alveolar structures are lost irrespective of the immediate placement of an implant at time of tooth extraction (Araujo & Lindhe 2005, Araujo et al. 2005). Furthermore, a marked difference in the reduction of the width of the socket walls after tooth extraction and immediate implant placement was observed depending on the anatomic location (i.e. premolar vs. molar sites) (Araujo et al. 2006). In that animal experiment, the reduction of the width of the socket walls was more pronounced at the thicker buccal wall of molar sites compared with that of the thinner wall of premolar sites (Araujo et al. 2006). Although the peri-implant marginal defect was resolved after 3 months, the bone modeling process in both areas (i.e. premolar and molar sites) was accompanied by a substantial reduction of the dimensions of both the buccal and the lingual socket walls.

Additional experimental findings indicated that the rate of healing and degree of resolution of marginal peri-implant bone defects after implant installation were dependent on whether or not the defect was prepared in a healed alveolar site or presented as a gap of a fresh extraction socket (Botticelli et al. 2006). Findings from that experiment revealed that, after 4 months, most defects prepared in a healed alveolar ridge were completely resolved, whereas healing of fresh extraction sockets was incomplete (Botticelli et al. 2006).

Evidence for the clinical effectiveness of immediate implant placement following extraction of maxillary and mandibular molars is limited (Schwartz-Arad et al. 2000, Artzi et al. 2003, Cafiero et al. 2008). Outcomes from a case series report (Schwartz-Arad et al. 2000) highlighted a marked difference between the 5-year cumulative survival rate of mandibular (e.g. 92%) versus maxillary (e.g. 82%) molars, respectively. Outcomes from a multicenter prospective cohort study demonstrated that the use of tapered-effect implants for the immediate replacement of maxillary and mandibular molars lost because of caries, endodontic failure or vertical root fracture represented a predictable treatment after an observation period of 12 months (Cafiero et al. 2008). In that study, no significant difference with respect to survival rate was observed comparing maxillary with mandibular molars after 12 months (Cafiero et al. 2008). It should be noted that in that study (Cafiero et al. 2008) tapered-effect implants were installed into fresh extraction sockets with intact alveolar bone walls.

Hence, the aim of this prospective controlled clinical trial was to compare soft tissue healing at immediate transmucosal implants placed in molar extraction sites associated with buccal self-contained dehiscences with that of implants placed in healed sites without buccal dehiscences.

Materials and methods

Sampling

A power calculation was carried out to determine the sample size using the implant as the statistical unit. Differences in pocket probing depth (PPD) between test and control implants were set as the primary outcome. To detect with 80% power a statistically significant difference for the primary outcome of δ=1.5 mm with a standard deviation of σ= 2.0 mm, a sample size of 15 test and 15 control implants was calculated.

Experimental design

The study was designed as a prospective controlled clinical trial of 12 months duration.

Test implants were immediately placed in molar extraction sockets associated with a buccal bone defect of ≥ 3 mm in height (Figure 1 A-B) and width (Figure 1 C-D), respectively. The buccal bone defects were treated according to the principles of Guided Bone Regeneration (GBR) using deproteinized bovine bone mineral granules (BioOss®, Geistlich Biomaterials, Wolhusen, LU, Switzerland) and a resorbable collagen membrane (BioGide®, Geistlich Biomaterials, Wolhusen, LU, Switzerland).

Control implants were placed in molar sites without buccal bone defects following tooth extraction and a 6-month healing period.
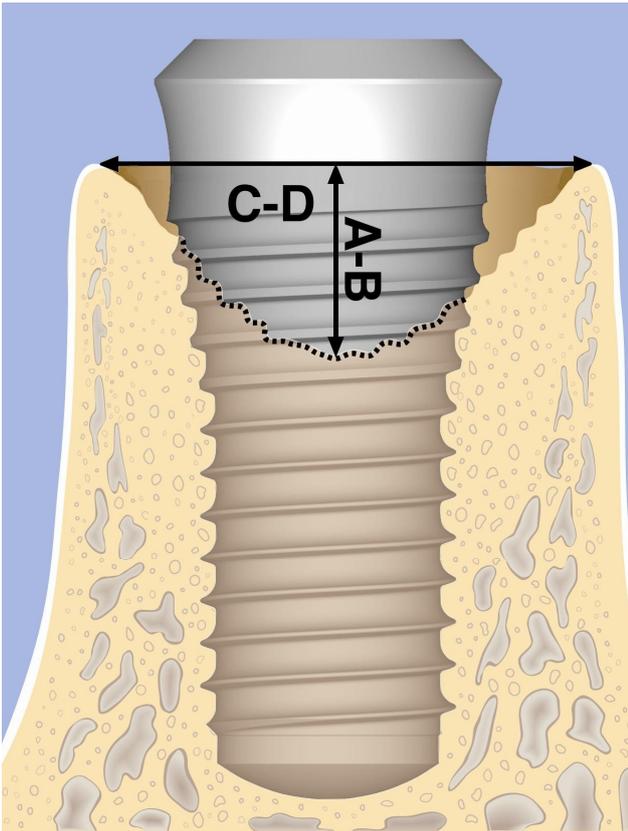
Figure 1. Characterization of the buccal bone dehiscence of ≥ 3 mm in apico-coronal height (A-B) and mesio-distal width (C-D).

A-B: Vertical distance from the SLA-turned transition on the implant surface (A) to the most coronal point of the mid-buccal alveolar crest (B).

C-D: Horizontal distance of the buccal bone dehiscence assessed from the mesio-buccal alveolar bone height (C) to the disto-buccal alveolar bone height (D).

Subject population

A total of 30 tapered implants of the Straumann[®] Dental Implant System (Straumann Institute, Basel, Switzerland) with a sandblasted and acid-etched (SLA) surface, an endosseous diameter of 4.8 mm, a shoulder diameter of 6.5 mm and a height of the turned neck 1.8 mm were installed in 30 subjects (Figure 2). All subjects were enrolled from the Department of Periodontology, University of Naples "Federico II", Naples, Italy.
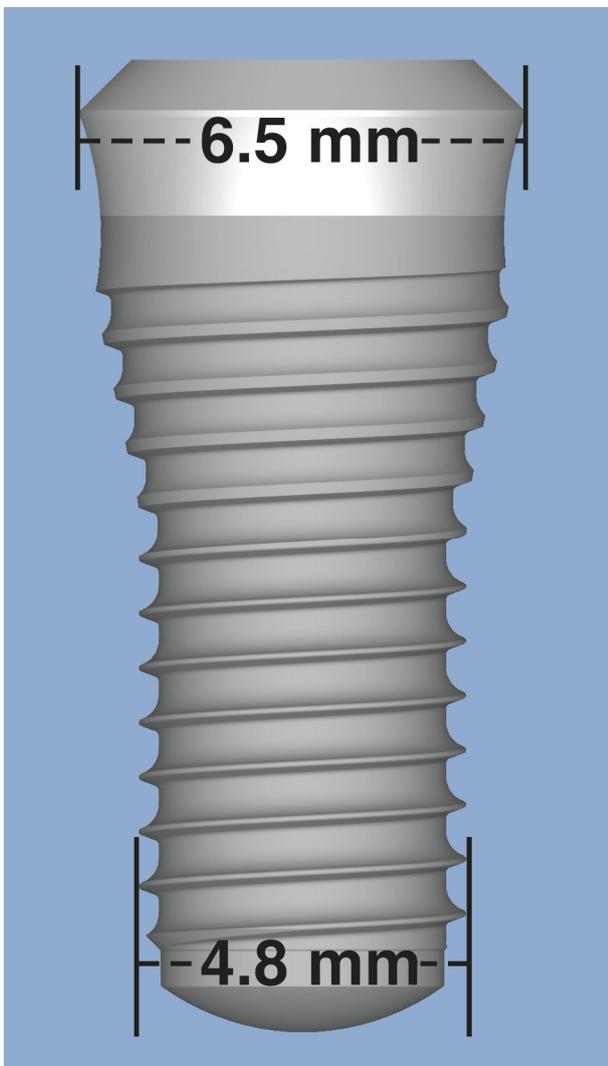

Figure 2. Tapered-effect (TE) implant of the Straumann[®] Dental Implant System (Straumann Institut AG, Basel, Switzerland) with an endosseous diameter of 4.8 mm and a shoulder diameter of 6.5 mm. The height of the supracrestal turned neck from the implant shoulder to the sand-blasted and acid-etched (SLA) implant surface amounts to 1.8 mm.

Subject selection

Inclusion criteria

- Age ≥ 18 years

- Absence of relevant medical conditions contraindicating surgical interventions

- Presence of a mandibular or maxillary molar to be extracted because of an endodontic failure, caries or vertical root fracture

- Presence of a tooth mesially and distally to the extraction site

- Full-mouth plaque score (FMPS) ≤ 25 % at baseline

- Full-mouth bleeding score (FMBS) ≤ 25 % at baseline

- Test group: Presence of a buccal bone dehiscence of ≥ 3 mm in apico-coronal height and in mesio-distal width after implant insertion (Figure 1 A-B and C-D, respectively)

- Control group: Presence of a buccal bone wall of ≥ 1 mm thickness at the most coronal part of the SLA implant surface

- Presence of ≥ 2 mm of keratinized tissue to allow soft tissue manipulation

- Presence of sufficient residual alveolar bone volume to achieve primary implant stability

- Signed informed consent

Exclusion criteria

- Mandibular or maxillary molars to be extracted for periodontal reasons (e.g. furcation involvement, angular bony defects)

- Pregnant or lactating females

- Cigarette, pipe or cigar smoking

- Full-mouth plaque score (FMPS) > 25 % at baseline

- Full-mouth bleeding score (FMBS) > 25 % at baseline

- Untreated periodontal conditions

- Clinical and/or radiographic signs of periapical pathology contraindicating immediate implant placement

- Previously augmented recipient sites for control implants

- Maxillary and mandibular third molars

- Failure to sign informed consent

The study protocol was submitted to and approved by the Ethical Committee of the University " Federico II ", Naples, Italy. Written informed consent was obtained and the study was conducted according to the principles of the Declaration of Helsinki on experimentation involving human subjects.

Experimental procedures

Clinical parameters

The following parameters were recorded at baseline and/or at the 12-month follow-up around teeth or implants:

- Full-Mouth Plaque Score (FMPS) at six sites per tooth (i.e. disto-buccal, buccal, mesio-buccal, mesio-oral, oral, disto-oral)

- Full-Mouth Bleeding Score (FMBS) at six sites per tooth (i. e. disto-buccal, buccal, mesio-buccal, mesio-oral, oral, disto-oral)

- Pocket Probing Depth (PPD) at four sites (i.e. distal, mid-buccal, mid-oral, mesial)

- Clinical Attachment Level (CAL) at four sites (i.e. distal, mid-buccal, mid-oral, mesial)

Surgical procedures

Molar extraction and implant placement were performed simultaneously (Figure 3).

Figure 3. Buccal view after extraction of tooth 16 and immediate implant placement in an extraction site with self-contained buccal defect. The transition line of the SLA-turned implant surface is at the level of the mesio-distal alveolar crest (see Fig. 1).

A full-thickness muco-periosteal flap was elevated extending to at least one tooth in mesial and distal direction. Following separation of the roots and careful tooth extraction, preparation of the implant bed in the area of the interradicular septum and implant placement were carried out. Tapered-effect (TE) implants of the Straumann® Dental Implant System (Straumann AG, Basel, Switzerland) with a sandblasted and acid-etched (SLA) surface, an endosseous diameter of 4.8 mm and a shoulder diameter of 6.5 mm were placed according to manufacturer's instructions. The turned neck portion of the implant (i.e. 1.8 mm) was positioned at the level of the alveolar crest in both test and control implants. Primary stability of the test implants was achieved in the remaining apical portion of the interradicular septum. The marginal gap between the implants and the inner walls of the extraction sockets as well as the buccal bone dehiscences of the test implants were regenerated by the use of a bioresorbable membrane supported by a bone substitute. Deproteinized bovine bone mineral particles with a size of 0.25 to 1.00 mm (BioOss®, Geistlich Biomaterials, Wolhusen, LU, Switzerland) were placed into the defect, followed by the punch and adaptation of a collagen membrane of porcine origin (BioGide®, Geistlich Biomaterials, Wolhusen, LU, Switzerland) around the neck of the implant. The barrier membrane extended 3-4 mm beyond the borders of the bone defect. After insertion of a non-beveled healing cap, the buccal and lingual/palatal flaps were repositioned and sutured around the neck of the implant using 4-0 non-resorbable sutures (Ethibond Excel, Ethicon, Johnson & Johnson, NJ, USA) aiming at a transmucosal wound healing.

Intrasurgical measurements (Test group)

The following intrasurgical measurements were recorded immediately after tooth extraction and implant placement (Figure 4):

- IS-BD: Vertical distance from the implant shoulder (IS) to the most apical extension of the bone defect (BD)

- C-BD: Vertical distance from the most coronal extension of the alveolar crest (C) to the most apical extension of the bone defect (BD)

- C-I: Horizontal distance from the height of the alveolar crest (C) to the implant surface (I)

- A-B: Height of the buccal dehiscence measured from the SLA-turned transition line (A) to the most coronal extension of the mid-buccal bone crest (B)

- C-D: Width of the buccal dehiscence measured from the mesio-buccal bone crest (C) to the disto-buccal bone crest (D)
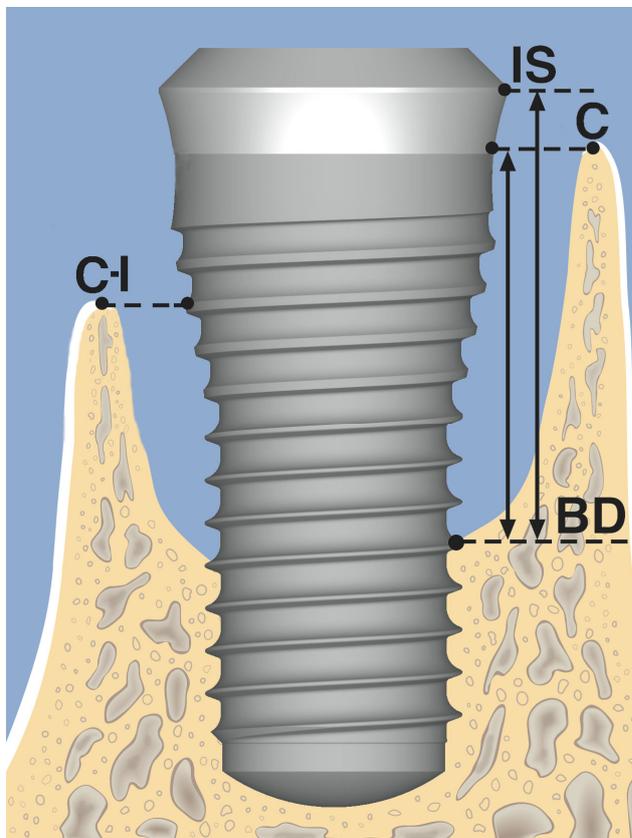

Figure 4. Bucco-oral schematic illustration of the marginal peri-implant defects at time of placement of test implants.

C-I: Horizontal distance of the marginal defect from the alveolar crest (C) to the implant (I) surface.

IS-BD: Vertical distance from the implant shoulder (IS) to the bottom of the marginal bone defect (BD).

C-BD: Vertical distance from the alveolar crest (C) to the bottom of the marginal bone defect (BD).

Post-surgical instructions and infection control

Post-operative pain was controlled with ibuprofen (e.g. 600 mg immediately before the surgical intervention and after 4 hours). In cases of contraindications to NSAIDs (e.g. ulcer, gastritis) acetaminophen (e.g. 500 mg immediately before the surgical intervention and after 6 hours) was prescribed. To minimize postoperative swelling, all subjects were instructed to intermittently apply an ice bag for the first 2 hours after the surgical intervention.

To prevent wound infection, all subjects received systemic antibiotics (e.g. amoxicillin with clavulanic acid) for 5 days postsurgically. Moreover, subjects were instructed to rinse twice daily with 0.12% chlorhexidine digluconate and to use modified oral hygiene procedures in the treated area for the first 4 post-operative weeks.

Modified oral hygiene instructions for the treated area were given to the subjects (Heitz et al. 2004). Starting on the third day after surgery and up to the fourth postsurgical week, subjects were advised to gently wipe the treated area by means of a very soft toothbrush. The toothbrush was soaked in chlorhexidine solution and used to wipe the peri-implant area with light vertical strokes. No interdental cleaning in the treated area with brushes, floss, or toothpicks by the patient was allowed in the first four weeks. Teeth not adjacent to the surgical site were cleaned using normal oral hygiene practices.

Sutures were removed at the two-week post surgical appointment. Post-surgical appointments consisting of professional supragingival tooth cleaning with rubber cup and chlorhexidine gel as well as interproximal cleaning with superfloss and chlorhexidine gel were performed 2, 4 and 6 weeks after implant installation. Four weeks after implant installation, subjects were instructed to resume normal oral hygiene procedures including full-mouth interproximal cleaning and to discontinue chlorhexidine mouth rinsing.

Delivery of fixed single-unit crowns

A provisional acrylic single-unit crown was cemented 3 months after implant placement. After a period of 30 ± 10 days, a definitive prosthetic reconstruction by means of a porcelain-fused-to-metal single unit crown was cemented.

Data analysis

The heterogeneity between test and control groups was verified using the Pearson χ^2 test. A χ^2 value < 0.05 was accepted to identify a statistically significant difference.

Because no differences were observed between test and control subjects, the implant was used as the statistical unit.

In each group all variables were expressed in millimeters with the exception of FMPS and FMBS scores that were expressed in percentages. Descriptive statistics (e.g. means ± standard deviation) were used to present the subject population.

The comparisons of the variables between test and control groups at the 12-month follow-up were performed using the unpaired t-test. A p value < 0.05 was accepted to identify a statistically significant difference.

The data analysis was performed using a commercially available statistical software package (NCSS-PASS®, Number Cruncher Statistical Systems, Kaysville, USA).

Results

Demographic data

The detailed characteristics of the subject population at baseline are presented in Table 1. After screening, a total of 30 subjects fulfilling the inclusion criteria were enrolled and allocated to either the test or control group. No statistically significant differences (χ^2 > 0.05) were observed with respect to age, gender, FMPS and FMBS comparing test with control subjects.

Table 1. Characteristics of the subject population at time of implant installation.

	Test Group N=15	Control Group N=15	χ^2
Age (years ± SD)	48.1 ± 16.5	49.5 ± 15.3	0.12 (NS)
Gender (%)	7 males (46.6%) 8 females (53.4%)	9 males (66.7%) 6 females (33.3%)	3.69 (NS)
FMPS (% ± SD)	10.3 ± 5.0	16.6 ± 5.2	0.06 (NS)
FMBS (% ± SD)	8.7 ± 5.1	12.1 ± 3.6	0.06 (NS)

FMPS: Full Mouth Plaque Score

FMBS: Full Mouth Bleeding Score

 A χ^2 value < 0.05 was accepted to identify a statistically significant difference.

NS: Not statitstically significant different

Table 2 summarizes the maxillary and mandibular implant locations. No statistically significant differences ($\chi^2 > 0.05$) were observed with respect to implant location when comparing test with control subjects.

Table 2. Distribution of test and control implants in the maxilla and mandible.

Location of implants	Test Group N=15	Control Group N=15	χ^2
Right maxillary 1st molar (16)	5	3	0.71 (NS)
Left maxillary 1st molar (26)	0	0	-
Left mandibular 1st molar (36)	3	4	0.83 (NS)
Right mandibular 1st molar (46)	0	0	-
Right maxillary 2st molar (17)	0	0	-
Left maxillary 2st molar (27)	3	4	0.83 (NS)
Left mandibular 2st molar (37)	4	4	1 (NS)
Right mandibular 2st molar (47)	0	0	-

A χ^2 value < 0.05 was accepted to identify a statistically significant difference.

NS: Not statistically significant different

Surgical outcomes

All subjects completed the 12-month follow-up examination. No implants were lost during this observation period yielding a one-year survival rate of 100%.

No post-surgical wound healing complications (i.e. bacterial infections) were observed. However, on the palatal aspects of all test implants placed in the maxillary first and second molar area an exposure of the collagen membrane was present at time of flap suturing due to the impossibility of soft tissue mobilisation.

Table 3 illustrates the reasons for molar extraction. The most frequent cause was root fracture (i.e. 60 %) followed by endodontic failures (i.e. 26.6 %) and caries (i.e. 13.4 %).

Table 3. Reasons for molar tooth extraction.

Reasons for molar tooth extraction	(%)
Root fracture	60
Endodontic failure	26.6
Caries	13.4

Table 4 summarizes the linear measurements around test implants at time of installation. The vertical distance from the implant shoulder (IS) to the most apical extension of the bone defect (BD) amounted to 10.8 ± 1.5 mm at the mesial, 10.5 ± 1.8 mm at the buccal, 9.8 ± 2.3 mm at the distal and 10.7 ± 1.9 mm at the oral site, respectively. The vertical distance from the most coronal extension of the alveolar crest (C) to the most apical extension of the bone defect (BD) was 9.0 ± 1.4 mm at the mesial, 2.9 ± 1.5 mm at the buccal, 7.7 ± 2.3 mm at the distal and 9.2 ± 1.9 mm at the oral site, respectively. The horizontal distance from the most coronal height of the alveolar crest (C) to the implant surface (I) was 1.9 ± 1.1 mm at the mesial, 1.7 ± 1.1 mm at the buccal, 2.0 ± 1.0 mm at the distal and 3.8 ± 0.8 mm at the oral site, respectively.

Table 4. Mean ± standard deviation (SD) of intrasurgical linear measurements assessed at four sites (i.e. mesial, buccal, distal, oral) around each test implant.

	Mesial	Buccal	Distal	Oral
IS-BD (mm)	10.8 ± 1.5	10.5 ± 1.8	9.8 ± 2.3	10.7 ± 1.9
C-BD (mm)	9.0 ± 1.4	2.9 ± 1.5	7.7 ± 2.3	9.2 ± 1.9
C-I (mm)	1.9 ± 1.1	1.7 ± 1.1	2.0 ± 1.0	3.8 ± 0.8

IS-BD: Vertical distance from the implant shoulder (IS) to the most apical extension of the bone defect (BD).

C-BD: Vertical distance from the most coronal extension of the alveolar crest (C) to the most apical extension of the bone defect (BD).

C-I: Horizontal width from the mid-buccal height of the alveolar crest (C) to the implant surface (I)

Table 5 shows that the vertical distance (i.e. A-B) of the buccal bone dehiscence of test implants amounted to 5.2 ± 2.6 mm whereas the horizontal dimension (C-D) was 7.9 ± 1.7 mm.

Table 5. Mean vertical (A-B) and horizontal (C-D) linear measurements ± standard deviation (SD) of the buccal self-contained bone dehiscences at test implants.

	Height (A-B) (mm ± SD)	Width (C-D) (mm ± SD)
Mean ± SD	5.2 ± 2.6	7.9 ± 1.7

A-B: Height of the buccal dehiscence measured from the SLA-turned transition (A) to the most coronal extension of the mid-buccal alveolar bone crest (B)

C-D: Width of the buccal dehiscence measured from the mesio-buccal alveolar bone crest (C) to the disto-buccal alveolar bone crest (D)

Table 6 summarizes the assessments of pocket probing depth (PPD) and clinical attachment level (CAL) at four sites (i.e. mesial, distal, buccal, oral) around test and control implants at the 12-month follow-up. The PPD of test implants was 4.13 ± 1.13 mm at the mesial, 3.7 ± 1.0 mm at the buccal, 4.13 ± 0.83 mm at the distal and 4.33 ± 0.98 mm at the oral site, respectively. The corresponding values for the control implants were 3.13 ± 0.52 mm at the mesial, 2.2 ± 0.8 mm at the buccal, 3.00 ± 0.65 mm at the distal and 3.20 ± 0.56 mm at the oral site, respectively.

The CAL values recorded around test implants were 3.80 ± 0.78 mm at the mesial, 4.7 ± 1.0 mm at the buccal, 4.80 ± 0.94 mm at the distal and 4.87 ± 0.92 mm at the oral site, respectively. The corresponding values for the control implants were 3.33 ± 0.72 mm at the mesial, 2.4 ± 1.0 mm at the buccal, 3.27 ± 0.70 mm at the distal and 3.33 ± 0.72 mm at the oral site, respectively.

Statistically significant differences ($p < 0.05$) were observed with respect to both PPD and CAL when comparing test and control implants at the 12-month follow-up.

Table 6. Comparison of mean pocket probing depths (PPD) ± standard deviation (SD) and mean clinical attachment levels (CAL) ± standard deviation (SD) assessed at four sites (i.e. mesial, buccal, distal, oral) at the 12-month follow-up between test and control implants.

	Mean PPD ± SD (mm)				Mean CAL ± SD (mm)			
	Mesial	Buccal	Distal	Oral	Mesial	Buccal	Distal	Oral
Test implants	4.13±1.13	3.7±1.0	4.13±0.83	4.33±0.98	3.80±0.78	4.7±1.0	4.80±0.94	4.87±0.92
Control implants	3.13±0.52	2.2±0.8	3.00±0.65	3.20±0.56	3.33±0.72	2.4±1.0	3.27±0.70	3.33±0.72
p-value	$p = 0.01$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p = 0.01$	$p < 0.001$	$p < 0.001$	$p < 0.001$

A p value < 0.05 was accepted to identify a statistically significant difference.

PPD: Pocket Probing Depth
CAL: Clinical attachment level

Discussion

The findings of this 12-month controlled clinical study demonstrated that wound healing at immediate implants placed into molar extraction sites associated with buccal self-contained dehiscences was inferior compared with that around implants placed in healed bone resulting in lack of complete osseointegration. Although multirooted teeth with bone loss due to periodontitis (e.g. vertical and furcation defects) had been excluded from the present study, immediate implant placement in molar sites was always accompanied by self-contained marginal defects at all aspects (i.e. mesial, distal, oral and buccal).

Outcomes from animal studies indicated that 1-2.25 mm wide self-contained peri-implant marginal defects without vertical bone dehiscence became filled with newly formed bone after a 4-month healing period without the use of grafting materials (Botticelli et al. 2003, 2004). Further experimental evidence demonstrated that the rate of healing and degree of resolution of self-contained marginal defects after implant installation were dependent on whether or not the defect was prepared in a healed alveolar site or presented as a void of a fresh extraction socket (Botticelli et al. 2006). Findings from that experiment (Botticelli et al. 2006) showed that, after 4 months, most defects prepared in healed bone were completely resolved, whereas healing of fresh extraction sockets was incomplete.

Clinical outcomes of a 12-month prospective cohort study showed that immediate transmucosal implant placement into extraction sockets with intact height of the alveolar walls represented a predictable treatment for the replacement of mandibular and maxillary molars lost because of reasons other than periodontitis (Cafiero et al. 2008). In that study (Cafiero et al. 2008), the residual self-contained defects present after molar extraction and immediate implant placement displayed intact buccal alveolar walls. The values of the residual marginal peri-implant defects recorded at the mesial, distal and oral aspects in the study by Cafiero et al. (2008) were comparable with those of the present study. A substantial difference, however, was observed at buccal aspects with respect to the

distance from the implant shoulder to the bottom of the defect (e.g IS-BD). The mean vertical distance IS-BD at buccal aspects amounted to 4.9 ± 4.6 mm in the study by Cafiero et al. (2008) whereas it was 10.5 ± 1.8 mm in the present study.

The presence of self-contained bone defects at the buccal aspect at time of immediate implant placement represented an additional challenge in the present study. Clinically, the buccal bone crest was, after molar extraction and immediate implant placement, at a more apical level compared with the mesial, distal and oral aspects. Furthermore, the mean width of the buccal bone dehiscence (e.g. 7.9±1.7 mm) present after molar extraction exceeded the corresponding mean height (e.g. 5.2±2.6 mm) in the present study. This is in contrast to the measurements of buccal bone dehiscences observed after extraction of single-rooted teeth and immediate-delayed implant placement (Nemcovsky et al. 2000). In that study (Nemcovsky et al. 2000) the mean height of the buccal bone dehiscence (e.g. 6.7± 2.2mm) exceeded the mean width (e.g 4.3±0.9 mm). Moreover, Nemcovsky and Artzi (2002) reported significant improvements in the reduction of buccal defect height and width after single-tooth extraction and immediate implant placement in conjunction with submerged wound healing. Hence, tooth morphology (e.g. single- versus multi-rooted teeth) yields different shapes of buccal dehiscences after tooth extraction, thereby influencing the ratio between height and width of the buccal marginal defect. This may be relevant for complete resolution of the marginal defect following immediate implant placement in conjunction with bone regenerative procedures.

Outcomes from an experimental study in the dog showed that the configuration of the marginal portion of artificial defects created in healed bone played an important role in terms of wound healing (Botticelli et al. 2004). Buccally open peri-implant defects of varying dimensions healed with less new bone formation compared with the other aspects of the same defect (e.g. mesial, distal and oral). The authors of that study (Botticelli et al. 2004) postulated that the observed compromised bone fill at buccal aspects was related

to an inadequate space maintaining effect provided by the resorbable collagen membrane without the concomitant use of autogenous bone or a bone substitute. Thus, the resorbable membrane used in that animal experiment (Botticelli et al. 2004) may have collapsed into the buccal defect during wound healing, thereby reducing space available for new bone formation at this specific site of the defect. In the present clinical study, the same resorbable collagen membrane as in the above mentioned animal experiment (Botticelli et al. 2004) was used in conjunction with immediate implant placement. However, in the present study the resorbable membrane had been adapted around the neck of the implant and had always been supported by deproteinized bovine bone particles covering the exposed buccal implant surface as well as the residual marginal gaps. Although a membrane support was provided, a compromised wound healing accompanied by incomplete osseointegratioin was observed when comparing test with control implants in the present study. Outcomes from previous experimental studies in dogs, however, showed that buccal peri-implant defects protected by a rigid expanded polytetrafluorethylene (e-PTFE) membrane with or without the use of bone grafts were completely resolved after 12-16 weeks of healing (Lekholm et al. 1993, Becker et al. 1995).

In conclusion, significant differences in clinical parameters (e.g. PPD and CAL) at all aspects (i.e. mesial, distal, oral, buccal) were recorded after 12 months when comparing immediate transmucosal implants placed into molar extraction sites associated with buccal self-contained dehiscences with control implants placed in healed bone. Hence, wound healing after immediate implant placement in molar extraction sites was inferior compared with that of control implants and resulted in lack of complete osseointegration.

Acknowledgement

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