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Peri-implant tissues at submerged and non-submerged titanium implants

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Abstract. The present experiment was performed to study the peri-implant tissue response to non-submerged (1-stage) and initially submerged (2-stage) implant installation procedures. 6 beagle dogs were used. All mandibular premolars and the 1st, 2nd and 3rd maxillary premolars were extracted. After 3 months of healing, 3 fixtures of the Astra Tech System were installed and submerged in the right (or the left) edentulous, premolar region in each of the 6 dogs. Radiographs were obtained immediately after fixture installation. In the radiographs, the distance between the abutment-fixture junction and the most "coronal" bone in contact with the implant surface was determined. 3 months later, abutments were connected to the initially submerged fixtures and another 3 fixtures of the same system were installed in the contralateral, edentulous premolar region. Abutments were, however, immediately connected to the newly-installed fixtures (non-submerged side; test side). The mucosal flaps were replaced, adjusted and sutured in such a way that the coronal portion of the abutments remained exposed in the oral cavity. A new set of radiographs were obtained from all 6 implant sites in each animal. A period of plaque control was initiated. Clinical examinations were performed and radiographs obtained from all implant sites after another 3 months and at the termination of the experiment. 9 months after the 1st fixture installation procedure, the animals were sacrificed, the mandibles were removed, and each implant region dissected. The most mesially-located implant sites were processed for ground sectioning. The remaining biopsies were processed and embedded in EPON. The histometric analysis included assessment of the vertical dimension of the marginal soft and mineralized peri-implant tissues. The ground sections were used for measurements describing (i) "bone to implant contact" and (ii) "bone density". It was observed that the mucosa and bone tissue that formed at implants placed in a non-submerged or a submerged procedure had many features in common. Thus, figures describing (i) the height of the mucosa, (ii) the length of the junctional epithelium and the height and quality of the zone of "connective tissue integration", (iii) the % of bone to implant contact as well as (iv) the density of the peri-implant bone, were similar in the submerged and the non-submerged groups. It is therefore suggested that a non-submerged (1-stage) installation technique may provide conditions for tissue integration that are similar to those obtained using a submerged (2-stage) approach.

Key words: dogs; histometry; dental implant; peri-implant mucosa; osseointegration; non-submerged implants; submerged implants

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Clinical and experimental studies have documented that soft and hard tissue integration may predictably occur to endosseous dental implants made of c.p. titanium. Results from the monitoring of patients that have been restored with dental implants have, in addition, demonstrated that osseointegration can be maintained on a long-term basis (for review, see Cochran (1996), Fritz (1996)). Several implant systems are composed of 2 parts; one fixture and one abutment part. With such systems the fixture is submerged in the jaw bone in a 1st surgical procedure and, following healing, the transmucosal abutment is connected in a 2nd-stage procedure. Other systems are composed of only 1 part and require only 1 surgical intervention. Both systems (the 2-stage and the 1-stage) give proper clinical anchor-

age and provide a predictable good long-range outcome of implant therapy. Ericsson et al. (1996) used a Labrador dog model to study some soft and hard tissue characteristics of initially submerged and non-submerged titanium implants. They reported that"... implants ad modum Brånemark, installed according to a 1-step or to a 2-step surgical procedure, will obtain similar soft tissue adaptation and proper bone anchorage (osseointegration)". Matching findings were published by Abrahamsson et al. (1996) who, in a beagle dog model, compared tissue integration that occurred following the installation of 3 different implant systems; one 1-part (non-submerged) and two 2-part (initially submerged) systems. It was observed that "correctly performed implant installation may ensure proper conditions for both soft and hard tissue healing" and that no quantitative or qualitative differences regarding soft- and hard-tissue integration could be observed between initially submerged and non-submerged implant systems.

The aim of the present experiment was to further study the peri-implant tissues formed following the installation of an original 2-part implant system used either in a submerged or non-submerged procedure.

Material and Methods

6 beagle dogs, about 1-year old, were used in the experiment*. All mandibular premolars ($_4P_4$,$_3P_3$,$_2P_2$,$_1P_1$) and the bilateral 1st, 2nd and 3rd maxillary premolars ($^1P^1$,$^2P^2$,$^3P^3$) were extracted. After 3 months of healing (day 0), 3 fixtures of the Astra Tech Implants Dental System (Astra Tech AB, Mölndal, Sweden; TiOblast™, 8×3.5 mm) were installed in the right (or the left) edentulous, mandubular premolar region in each of the 6 dogs. An incision was made through the mucosa at the crest of the alveolar ridge. Buccal and lingual full thickness flaps were elevated, and self-tapping fixtures were placed in accordance with the recommendations given in the manual for this particular implant system. The implants were placed in such a way that the fixture margin coincided with the bone crest. Cover screws were connected and the mucoperiosteal flaps were resutured to submerge the fixtures. The sutures were removed after 2 weeks. Radiographs were obtained immediately after fixture installation using a modified Eggen technique (Eggen, 1969). In the radiographs, the distance between the most "coronal" part of the fixture (i.e., abutment-fixture junction; A/F) and the most "coronal" bone judged to be in contact with the implant surface (B), was determined at the mesial and distal aspect of each implant. The measurements were carried out in a Leica DM-RBE® microscope (Leica, Germany) equipped with an image system (Q-500 MC® Leica Germany).

3 months later, abutments (Uni Abutment height: 1.5 or 3 mm, angle: 45°) were connected to the initially-submerged fixtures (submerged side; control side). During the same session, another 3 fixtures (Astra Tech Implants Dental System; Astra Tech AB, Mölndal, Sweden; TiOblast™, 8×3.5 mm) were installed in the contralateral, edentulous premolar region and in the manner described above. Abutments (Uni Abutment h: 1.5 or 3 mm, angle: 45°) were, however, immediately connected to the newly-installed fixtures (non-submerged side; test side). The mucosal flaps were replaced, adjusted and sutured in such a way that the coronal portion of the abutments remained exposed in the oral cavity. A new set of radiographs were obtained from all 6 implant sites in each animal using a custom made film holder device (modified from an Eggen holder; Eggen, 1969), connected to the posterior implant. The sutures were removed after 2 weeks.

A period of plaque control was initiated. This included daily cleaning of all teeth and exposed implant surfaces using toothbrush and dentifrice. Clinical examinations were performed and radiographs obtained from all implant sites after 3 months and 6 months. The clinical examinations included assessment of plaque and soft tissue inflammation. The plaque index (PlI; Silness & Löe 1964) was used to identify plaque on buccal, lingual, mesial and distal surfaces and a modified gingival index (MGI, Lobene et al. 1986) was used to evaluate the condition of the periimplant mucosa at the corresponding locations.

9 months after the first fixture installation procedure (control side), the animals were sacrificed with an overdose of sodium-pentothal and perfused with a fixative through the carotid arteries. The fixative consisted of a mixture of 5% glutaraldehyde and 4% formaldehyde buffered to pH 7.2 (Karnovsky 1965). The mandibles were removed and placed in the fixative. Each implant region was dissected using a diamond saw (Exakt®, Kulzer, Germany). While the most mesially-located implant sites of each side were processed for ground sectioning (Donath & Breuner 1982, Donath 1988), the remaining biopsies were processed acccording to the "fracture technique" as described by Berglundh et al. (1994) and embedded in EPON.

Ground sections. The tissue samples were dehydrated in serial steps of alcohol concentrations and subsequently embedded in methyl-methacrylate (Technovit® 7200 VLC, Exakt®), Kulzer, Germany). The blocks were cut in a mesio-distal plane using a cutting-grinding unit (Exakt® Apparatebau, Norderstedt, Germany). From each implant site, 2 central sections were prepared and further reduced to a final thickness of approximately 20 μm using a micro – grinding unit (Exakt® Apparatebau, Norderstedt, Germany). The sections were stained in toluidine blue (Donath 1993) or Masson-trichrome (Donath 1993).

EPON sections. The biopsies selected for the "fracture technique" (Berglundh et al. 1994) were placed in EDTA. Before the hard tissue was fully decalcified, incisions were placed at the mesial and distal aspects of the implants. The cuts penetrated the entire peri-implant tissue and were made parallel with the long axis of the implants. The specimen was divided into 1 buccal and 1 lingual unit. These units were further separated into 1 mesio-buccal, 1 disto-buccal, 1 mesio-lingual and 1 disto-lingual portion. Decalcification was completed in EDTA and dehydration performed in serial steps of ethanol concentrations. Secondary fixation in O_sO_4 was carried out and the units were finally embedded in EPON®; (Schroeder 1969). Sections were produced from each tissue unit with the microtome set at 3 μm. The sections were stained in PAS and toluidine blue (Schroeder 1969). 5 sections, selected to represent the entire part of each of the 4 units, i.e; in all, 20 sections from each implant site were used for the histological examination. Hence, all aspects (mesial, distal, buccal and lingual) of the peri-implant tissues were included in the analysis of the EPON embedded sections.

* The protocol of the present study was approved by the regional Ethics Committee for Animal Research, Göteborg, Sweden.

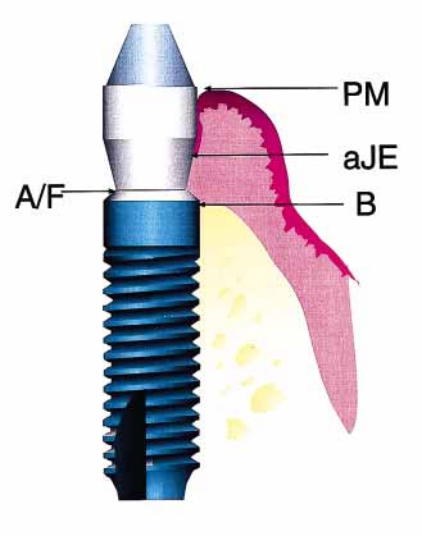

Fig. 1. Schematic drawing illustrating the landmarks used for the histometric measurements. PM – the marginal portion of the peri-implant mucosa, aJE – the level of the apical termination of the junctional epithelium, B – the marginal level of "bone to implant contact", A/F – the abutment/fixture borderline.

Histometric analysis

The histometric analysis, performed in the EPON sections, included assessment of the vertical dimension of the marginal soft and mineralized peri-implant tissues. The following landmarks were used for the linear measurements (Fig. 1): PM – the marginal position of the peri-implant mucosa, aJE – the apical termination of the junctional epithelium, B – the marginal level of bone to implant contact and A/F – the level of the abutment/fixture border. The distances between the landmarks were determined in a Leica DM-RBE® microscope (Leica, Germany) equipped with an image system Q-500 MC® (Leica Germany).

Morphometric analysis

The morphometric measurements, (EPON sections), were confined to a 200 μm wide compartment of the "zone of connective tissue integration" (Berglundh et al. 1991), i.e., the portion of the connective tissue that was located between the apical cells of the junctional epithelium (aJE) and the marginal level of bone to implant contact (B). The composition of the connective tissue was analyzed with respect to the content of collagen (Co), vessels (V), fibroblasts (Fi) and residual tissue (R; the remaining tissue constituents such as leukocytes, nerves and matrix components lumped together). The measurements were carried out in a Leica DM-RBE® microscope (Leica, Germany) equipped with an image system Q-500 MC® (Leica, Germany). A point-counting procedure was performed using a lattice comprising 100 light points (Schroeder & Münzel-Pedrazzoli 1973) superimposed over the connective tissue area at a magnification of ×1000.

Bone tissue analysis

The ground sections were used for measurements describing (i) bone to implant contact and (ii) bone density (Abrahamsson et al. 1996). The amount of mineralized bone that was in direct contact with the implant surface was first determined. Subsequently, the proportion of mineralized bone tissue within a 300-μm wide zone lateral to (i) the coronal unthreaded and (ii) the remaining threaded part of the fixture was assessed. This analysis was carried out in a Leica DM-RBE® microscope (×50) (Leica, Germany) equipped with an image system Q-500 MC® (Leica, Germany), and for the point-counting procedure a lattice comprising 100 light points (Schroeder & Münzel-Pedrazzoli 1973) was superimposed over the bone tissue area.

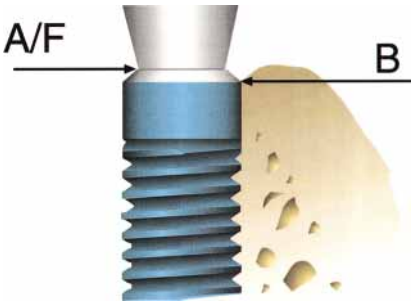

Fig. 3. Schematic drawing illustrating the marginal level of bone to implant contact (B) at fixture installation. Note that B is located 0.3 mm below the fixture margin (A/F).

Statistical analysis

Mean values for the different variables were calculated for each implant and animal. Differences between the test and control units were analyzed using the Student *t*-test for paired observations. The null hypothesis was rejected at $p<0.05$.

Results

Clinical observations

2 fixtures, 1 in each of 2 dogs and representing the control implants (submerged) perforated the mucosal lining during the 1st month after fixture installation. These two control sites as well as the contralateral test implants,

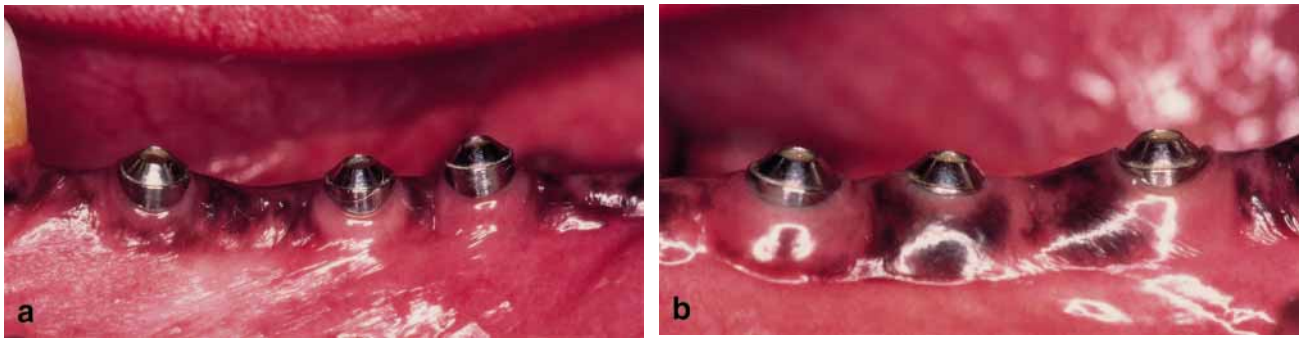

Fig. 2. Clinical photographs from one dog of the control; initially submerged (a) and test; non-submerged (b) implants at the final examination (day 270).

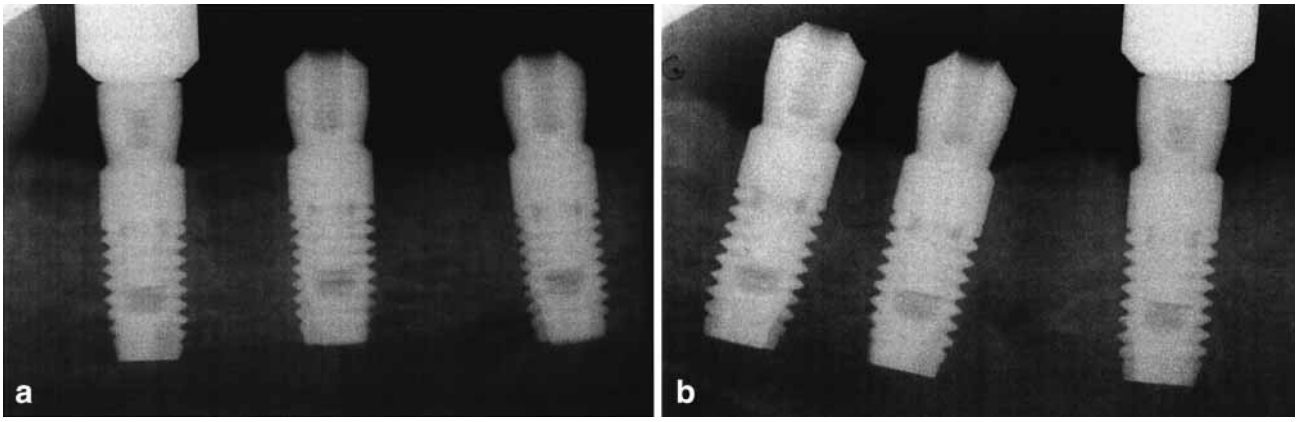

Fig. 4. Radiographs representing one control; initially submerged (a) and one test; nonsubmerged (b) implant region at the final examination (day 270).

were excluded from the analysis. All remaining implant sites healed uneventfully.

The clinical examinations performed after 3 and 6 months of plaque control disclosed (i) the presence of only minute amounts of plaque on the abutment surfaces, and (ii) that the condition of the mucosae at most implant sites was normal, i.e., showed no sign of inflammation (Fig. 2). The overall mean Pl.I. scores at 6 months varied in both groups between 0.13 and 0.15. The corresponding mean MGI scores varied also within a narrow range (0.14 and 0.20) in the test and control groups.

Radiographic measurements

Table 1 describes the results from the radiographic measurements. The marginal level of bone to implant contact (B; Fig. 3) in the radiographs obtained immediately after fixture installation coincided with the most marginal portion of the cylindrical part of the fixture, i. e., was in both groups positioned at a distance about 0.3 mm below the fixture margin (A/F; Fig. 3). In the control group, the radiographic bone level (B) was found to slightly decrease (0.23 mm) between day 0 and 3 months (abutment connection). The interval between 3 months and 9 months disclosed in the control group a minor additional apical displacement of the bone level (0.19 mm). The corresponding (3 months–9 months) alteration in the test group was 0.30 mm (Fig. 4).

Gross histological and histometric observations

The results of the histometric measurements are reported in Table 2. The peri-implant mucosa at the test and control sites was on the average between 3.0 and 3.2 mm high (Fig. 5). The mucosa was covered with a keratinized oral epithelium which was continuous with a junctional epithelium facing the titanium surface of the implant. The height of the junctional epithelium (PM-aJE) was 2.0 mm and 1.9 mm, for the test and control sites, respectively. The connective tissue compartment located between aJE and B (i.e. "zone of connective tissue integration"), was

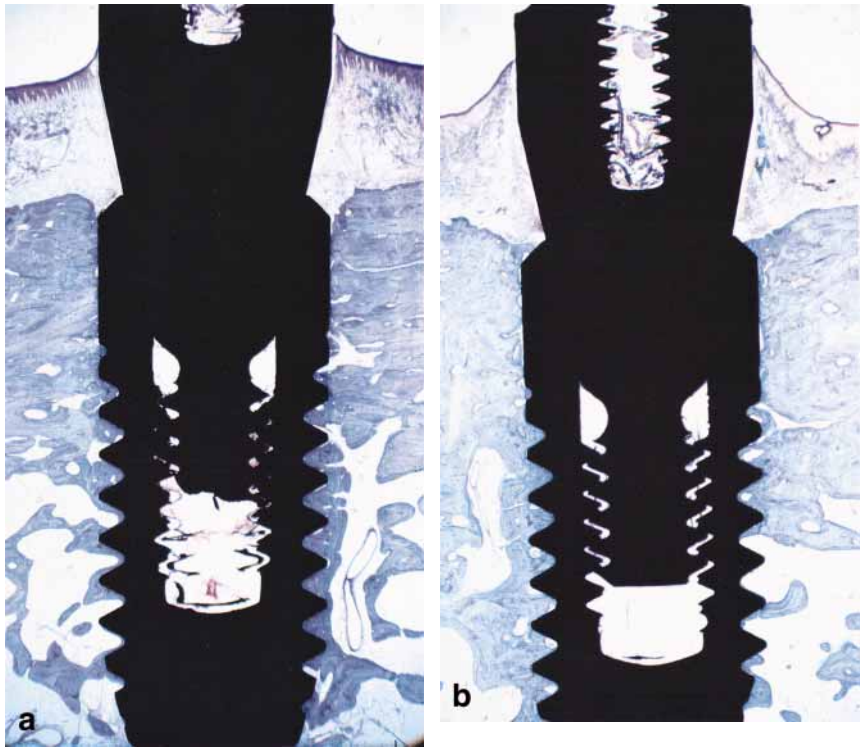

Fig. 5. Mesio – distal ground-sections of one control; initially submerged (a) and one test; non-submerged) (b) implant and their surrounding soft and hard peri-implant tissues. Toluidine blue, original magnification ×16.

Table 1. Results of the radiographic measurements; bone level alterations between day 0–90, 90–180 and 180–270; mean values and standard deviation (SD)

	Non-submerged implants		Submerged implants	
Day	mean	SD	mean	SD
0–90	–	–	−0.23	0.24
90–180	−0.20	0.11	−0.10	0.12
180–270	−0.10	0.07	−0.09	0.17
total	−0.30	0.12	−0.42	0.20

The landmarks are described in Fig. 1.

Table 2. Results from the histometric measurements

	PM-B		PM-aJE		aJE-B		A/F-B	
mm	mean	SD	mean	SD	mean	SD	mean	SD
non-submerged	3.15	0.34	1.97	0.52	1.18	0.31	0.68	0.33
submerged	3.00	0.39	1.85	0.51	1.16	0.28	0.85	0.32

The landmarks are described in Fig. 1. Mean values and standard deviations (SD).

Table 3. Results from the morphometric measurements

	Co		V		Fi		R	
(%)	mean	SD	mean	SD	mean	SD	mean	SD
non-submerged	80.01	4.47	3.53	0.89	13.38	3.36	3.08	1.08
submerged	81.20	2.07	3.30	1.28	12.58	1.37	2.92	1.31

The volume % of the connective tissue occupied by collagen (Co), vascular structures (V), fibroblasts (Fi) and residual tissue (R). Mean values and standard deviations (SD).

Table 4. Proportion of bone to implant contact (%)

	Non-submerged		Submerged	
(%)	mean	SD	mean	SD
unthreaded part	74.96	11.61	72.58	12.77
threaded part	61.38	4.90	66.71	9.67

Mean values and standard deviations (SD).

Table 5. Bone density (%)

	Non-submerged		Submerged	
(%)	mean	SD	mean	SD
unthreaded part	84.56	3.72	81.90	4.48
threaded part	45.76	12.29	48.90	7.25

Mean values and standard deviations (SD).

about 1.2 mm high in both the test and the control sites and was composed of a dense collagenous tissue including only few vascular structures, scattered fibroblasts and few inflammatory cells. The distance between A/F and B (marginal position of bone to implant contact) was on the average 0.7 mm in the test group and 0.9 mm in the control group of initially submerged implants.

Morphometric observations

The results from the morphometric measurements, which were confined to a 0–200 μm wide zone lateral to the implant in the supra-crestal connective tissue, are presented in Table 3. While the collagen fraction (Co) of the connective tissue for the test and control sites was 80.0% and 81.2%, the volume fraction occupied by fibroblasts (Fi) was 13.4% and 12.6%, respectively. The density of vascular units (V) was low; 3.5% (test) and 3.3% (control) and the % of residual tissue (R) varied for the 2 groups between 3.1% and 2.9%.

Bone tissue analysis

The % of bone to implant contact was 75.0% for the test implants and 72.6% for the controls within the unthreaded marginal portion of the fixtures (Table 4). The corresponding figures for the threaded part of the fixtures were 61.4% and 66.7%.

The proportion of mineralized bone (bone density) in a 300-μm wide zone adjacent to the fixture was similar in the test and control group (Table 5). Thus, the bone density lateral to the marginal unthreaded portion was 84.6% in the test and 81.9% in the control group. The corresponding values for the remaining threaded part of the fixtures were 45.8% (test group) and 48.9% (control group).

No statistically significant differences were observed between test and control units regarding any of the parameters studied.

Discussion

The findings from the present experiment disclosed that the mucosa and bone tissue that formed at implants placed in a non-submerged or a submerged procedure had many features in common. Thus, figures describing (i) the height of the mucosa, (ii) the length of the junctional epithelium and the height and quality of the zone of "connective tissue integration", (iii) the % of bone to implant contact as well as (iv) the density of the peri-implant bone were similar in the submerged and the non-submerged groups. It is therefore suggested that a non-submerged (1-stage) installation technique may provide conditions for tissue integration that are similar to those obtained using a submerged (2-stage) approach.

The histometric measurements performed in the present study revealed that in both groups, the height of the peri-implant mucosa was about 3.0–3.2 mm, the length of the junctional epithelium was about 1.9–2.0 mm and that the zone of connective tissue integration was 1.2 mm long. These results corroborate data previously reported from experiments in the dog model using

either a submerged or a non-submerged implant installation approach (Berglundh et al. 1991, Buser et al. 1992, Abrahamsson et al. 1996, Berglundh & Lindhe 1996, Cochran et al. 1997). Our observations are also, in some aspects, in agreement with figures presented by Weber et al. (1996) from a study examining the peri-implant tissues around 19 initially non-submerged and 19 submerged ITI® implants in 6 beagle dogs. The authors stated that both with respect to the overall dimension of the peri-implant mucosa and the marginal level of bone-to-implant contact, the 2 techniques yielded similar results. Weber et al. (1996), however, also observed that the junctional epithelium extended more apically in the submerged (1.71±0.13 mm) than in the non-submerged (1.18±0.27 mm) implant group. This observation is not in agreement with data from the present experiment in which the junctional epithelium in both the submerged and non-submerged groups was about 2 mm long, i.e., matching the epithelial lining in the submerged group of Weber et al. (1996).

This difference between the 2 studies is difficult to explain, but may be related to experimental design, biopsy processing, histological technique and/or to the presence of inflammatory lesions in the mucosa during healing following abutment connection. While the carefully-performed plaque control program in the present study prevented peri-implant mucositis in both groups of implants, Weber et al. (1996) reported on the presence of clinically-visible inflammation in the mucosa following abutment connection of the initially submerged implants.

The current findings furthermore revealed that (i) the contact area between the fixture and the surrounding bone as well as (ii) the density of this peri-implant bone did not differ between the initially submerged and non-submerged implants. This observation is in agreement with findings previously reported by Gotfredsen et al. (1991), who compared tissue reactions adjacent to submerged and non-submerged ITI® implants (hollow cylinders) in a group of green vervet monkeys after 22 weeks of healing. Their morphometric analysis revealed that the amount of osseointegration achieved, expressed as the "bone-to-implant contact length fraction", was almost identical in the 2 implant groups. On the other hand, Levy et al. (1996) studied healing around submerged and non-submerged implants in beagle dogs and reported that values describing "bone-to-implant contact" were greater in submerged than non-submerged implants. The submerged implants in the study by Levy et al. (1996) were kept in a submerged position during the entire experiment (6 weeks) and were consequently not exposed to the oral environment. This difference regarding study design and the length of the healing period may explain the different outcome in the study referred to and the present experiment. In addition, the submerged (control) implants in the current study were placed 3 months before the non-submerged (test) implants. Hence, the overall bone-healing period for the control implants was 9 months while the corresponding period for the test group was 6 months. Despite the additional 3 "submerged" months in the control group, no differences were observed between the submerged and non-submerged implants regarding the quantity and quality of osseointegration.

In the present study, it was noted that the most marginal position of "bone, to-implant contact" after 6–9 months of healing was located between 0.68 mm (non-submerged) and 0.85 mm (submerged) apical of the abutment/fixture junction. Since the conical part of the fixture used is 0.3 mm high, these figures correspond to an apical shift of the marginal bone level of about 0.38 mm and 0.55 mm, respectively (Fig. 3). The measurements performed in radiographs obtained during the experiment disclosed matching results regarding bone level alterations (0.30 mm versus 0.42 mm). This amount of osseointegration is in accordance with that observed by Weber et al. (1996), who reported that the marginal bone level around titanium implants after $4^1/_2$ months of healing was almost identical at initially submerged and non-submerged implants, i.e., 0.9 mm and 1.0 mm, respectively. In contrast, Ericsson et al. (1996) described radiographical and histological features of initially submerged and non-submerged implants in 5 Labrador dogs. Their study protocol was similar to that used by Weber et al. (1996), i.e., the fixtures (Brånemark System®) of both groups were installed in one session while, in the submerged implant group, the abutment connection was performed 3 months later. The authors concluded that implants installed according to a "1-step or 2-step surgical procedure" obtained matching soft tissue adaptation and bone anchorage (osseointegration) characteristics. Ericsson et al. (1996) further noted that in the interval between fixture installation and 6 months, radiographic bone loss occurred that amounted to 2.6 mm and 2.1 mm at their initially non-submerged and submerged implants. This difference between the present findings and those of Weber et al. (1996) on the one hand side and the results by Ericsson et al. (1996) on the other, is most likely explained by the characteristics of the implant systems used in the experiment. In the Ericsson et al. (1996) study, a 2-part system (Brånemark System®), with a microgap between the fixture and the abutment part, was used. In the experiment by Weber et al. (1996) and in the present experiment, either a 1-part implant or a 2-part implant without a microgap (conical seal) was installed. It has been observed that following abutment connection, bacteria from the oral cavity may contaminate the inner region (including the microgap) of the Brånemark System®, and that this in turn may result in some loss of marginal bone (Ericsson et al. 1995, Persson et al. 1996). This observation is consistent with data presented by Hermann et al. (1997). They worked with foxhounds and studied crestal bone changes around unloaded non-submerged and submerged, 1-part or 2-part, titanium implants. The 2-part implants had a considerable large microgap between the fixture and the abutment part. In some implant sites, the microgap was placed above and in other sites below the bone crest. The authors reported that the location – above or below the bone crest – of the microgap had a significant effect on the bone level.

Acknowledgments

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Zusammenfassung

Periimplantäres Gewebe an geschlossen und nicht-geschlossen eingeheilten Titanimplantaten

Das vorliegende Experiment wurde durchgeführt, um die Reaktion des periimplantären Gewebes an geschlossen (2-zeitig) und nicht-geschlossen (1-zeitig) einheilenden Implanta-

tionsmaßnahmen zu studieren. Es wurden sechs Beaglehunde verwendet. Alle Unterkieferprämolaren und die 1., 2. sowie 3. Oberkieferprämolaren wurden extrahiert. Nach einer dreimonatigen Heilungsphase wurden 3 Implantate des Astra Tech Systems im rechten, (oder linken) zahnlosen Prämolarenbereich bei jedem der Hunde geschlossen eingebracht. Sofort nach dem Einbringen der Implantate wurden Röntgenbilder angefertigt. Anhand der Röntgenbilder wurde der Abstand zwischen der Abutmentauflage und dem koronalsten Anteil des Knochens, der mit dem Implantat in Verbindung steht bestimmt. 3 Monate später wurden die geschlossen eingeheilten Implantate mit den Abutments verbunden und weitere drei Implantate des gleichen Systems im kontralateralen, zahnlosen Prämolarenbereich eingebracht. Die Abutments wurden jedoch sofort mit den neu gesetzten Implantaten verbunden (nicht-geschlossene Region; Testregion). Die Mukosalappen wurden reponiert und so mit Nähten fixiert, daß der koronale Anteil der Abutments dem Mundmilieu ausgesetzt war. Von allen 6 Implantationsbereichen eines jeden Tieres wurde ein weiterer Satz von Röntgenbildern angefertigt. Jetzt begann die Periode der Plaquekontrolle. Nach weiteren 3 Monaten und zum Ende des Experiments wurden klinische Untersuchungen und Röntgendiagnostik an allen Implantatbereichen durchgeführt. 9 Monate nach der ersten Implantationsmaßnahme wurden die Tiere geopfert, der Unterkiefer entfernt und von jedem Implantationsbereich Schnitte angefertigt. Die mesialsten Anteile der Implantate wurden für die Dünnschliffe präpariert. Die verbliebenen Biopsien wurden präpariert und in EPON eingebettet. Die histometrische Analyse beinhaltete die Messung der vertikalen Dimension des periimplantären marginalen Hart- und Weichgewebes. Die Dünnschliffe wurden für die folgenden Messüngen verwendet: (1) "Knochen zu Implantat-Kontakt" und (2) Knochendichte. Es wurde beobachtet, daß die Mukosa und das Knochengewebe, das sich an den geschlossen oder nicht-geschlossen eingeheilten Implantaten gebildet hat, viele gemeinsame Merkmale hat. Daher waren die Abbildungen, die folgendes beschrieben hatten: (1) die Höhe der Mukosa, (2) die Länge des Saumepithels sowie die Höhe und Qualität der Zone mit bindegewebiger Integration, (3) der Prozentsatz des Knochen-Implantatkontaktes als auch (4) die Dichte des periimplantären Knochens zwischen den geschlossen oder nicht-geschlossen eingeheilten Implantaten sehr ähnlich. Man kann daher annehmen, daß ein nicht-geschlossenes (1-zeitiges) Vorgehen ähnliche Bedingungen der Gewebeintegration liefern kann, wie sie bei der geschlossenen (2-zeitigen) Technik gegeben sind.

Résumé

Tissus paroïmplantaires au niveau des implants en titane enfouis et non-enfouis

L'expérience présente a été effectuée pour étudier la réponse du tissu paroïmplantaire à l'installation d'implants non-enfouis (une étape) ou enfouis initialement (2 étapes). 6 chiens Beagle ont été utilisés. Toutes les prémolaires mandibulaires et les 1ères, 2èmes et 3èmes prémolaires maxillaires ont été avulsées. Après 3 mois de guérison, 3 implants du système Astra Tech ont été placés et enfouis sur la droite (ou la gauche) de la région prémolaire édentée chez chacun des 6 chiens. Des radiographies ont été effectuées immédiatement après le placement des implants. Sur les radiographies, les distances entre la jonction pilier-implant et la partie la plus coronaire de l'os en contact avec la surface de l'implant ont été déterminées. 3 mois après, les piliers ont été connectés avec les installations submergées initialement et trois autres implants du même système ont été placés dans la région prémolaire édentée contralatérale. Les piliers ont cependant été immédiatement connectés avec les nouveaux implants installés (côté non-enfoui; côté test). Les lambeaux muqueux ont été replacés, ajustés et suturés de telle manière que la portion coronaire des implants restait exposée à la cavité buccale. Une nouvelle série de radiographies ont été obtenues des 6 implants chez chaque animal. Une période de contrôle de plaque dentaire a débuté. Les examens cliniques ont été effectués et des radiographies obtenues de tous les sites implantaires après 3 mois et à la fin de l'expérience. 9 mois après le premier processus d'installation des implants, les animaux ont été tués et les mandibules enlevées et chaque région implantaire disséquée. Les sites implantaires situés le plus en mésial, ont été utilisés pour les grosses coupes. Les biopsies restantes ont été enrobées dans l'EPON. L'analyse histométrique comprenait la mesure de la dimension verticale des tissus marginaux mous et minéralisés paroïmplantaires. Les grosses coupes ont été utilisées pour les mesures décrivant; (i) le contact os-implant et (ii) la densité osseuse. La muqueuse et le tissu osseux formés au niveau des implants et placés de manière non-enfouie ou de manière enfouie avaient beaucoup en commun. Les figures décrivant; (i) la hauteur de la muqueuse, (ii) la longueur de l'épithélium de jonction, et la hauteur et qualité de la zone d'intégration de tissu conjonctif, (iii) le % de contact os-implant, ainsi que (iv) la densité de l'os paroïmplantaire étaient semblables dans les deux groupes d'implants. Un implant non-enfoui et donc placé en une étape peut donc s'accompagner d'une intégration tissulaire semblabie à celle obtenue dans l'approche en 2 étapes.

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