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Case Report

Correlation between early perforation of cover screws and marginal bone loss: a retrospective study

Nele Van Assche[1], Bruno Collaert[2,3], Wim Coucke[4] and Marc Quirynen[1]

[1]Department of periodontology, Catholic University Leuven, Leuven, Belgium; [2]Department of Periodontology, Faculty of Odontology, Malmö University, Malmö, Sweden; [3]Centre for Periodontology and Implantology, Leuven, Belgium; [4]Department of Clinical Biology, Scientific Institute of Public Health, Brussels, Belgium

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Abstract

Aim: This retrospective study aimed to determine the consequence of early cover screw exposure on peri-implant marginal bone level.

Material and Methods: Sixty Astra Tech® MicroThread implants installed in partially edentulous jaws were compared: 20 implants were placed following a two-stage procedure and were unintentionally exposed to the oral cavity (two-stage exposed), 20 implants were placed following a two-stage procedure and were surgically exposed after a subgingival healing time of 3–6 months (two-stage submerged), and 20 implants were placed following a one-stage surgical protocol (one-stage). Digital radiographs were taken at implant placement for all implants, and after abutment surgery for the two-stage exposed and two-stage submerged groups or after 3 months for the one-stage group. Bone loss mesially and distally was measured with an on-screen cursor after calibration.

Results: Mean bone re-modelling was 1.96 mm (range: 0.2–3.2 mm) around the two-stage exposed implants, 0.01 mm (range: 0.0–0.3 mm) around the two-stage submerged implants and 0.14 mm (range: 0.0–1.2 mm) around the one-stage implants.

Conclusion: The unintentional perforation of two-stage implants resulted in significant bone destruction, probably because the biological width was not considered.

Key words: bone loss; cover screw; exposure; implant; perforation

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Brånemark et al. (1969) introduced the two-stage surgical protocol in implant dentistry with successful outcomes. They stated that hermetical closure of the gingival tissues minimized the risk of infection and prevented apical downgrowth of the epithelium (Brånemark et al. 1977, Adell et al. 1981). Recently, more and more implants are placed following a one-stage surgical approach where an (healing) abutment is placed at the time of implant insertion. Reports have shown that bone re-modelling around the one-stage and two-stage implants is similar (Collaert & De Bruyn 1998, Cecchinato et al. 2004, Engquist et al. 2005).

In some cases, with poor bone quality or when the provisional prosthetic re-construction cannot be adjusted effectively to prevent undesirable loading, a two-stage approach can be indicated. When gingival tissues above the cover screw of a two-stage implant are perforated unintentionally during the healing phase, an inflammatory reaction occurs, resulting in marginal bone destruction (Tal et al. 2001). The aim of this case series was to compare early marginal bone level changes around implants placed in a two-stage procedure (two-stage submerged) with implants placed in a one-stage procedure (one-stage) and implants placed in a two-stage procedure, but unintentionally exposed during the healing period (two-stage exposed).

Conflict of interest and source of funding statement

The authors declare that they have no conflict of interests.

Material and Methods

This retrospective study was based on 60 Astra Tech® MicroThread implants (AstraTech, Molndal, Sweden), installed in partially edentulous jaws. All implants were placed by the same surgeon,

following a crestal incision. The top of the implant was placed at or below the bone level. A one-stage surgical approach was the treatment of choice. A two-stage surgical protocol was used (1) if the patient wished to wear the removable denture during healing time for esthetical and/or functional reasons, (2) because of economic reasons (provisional bridge in case immediate loading is more expensive), and/or (3) if the primary stability was deemed insufficient by the surgeon (the latter only occurred sporadically).

Patients

In all patients treated for partial edentulism in a two-stage approach between April 2004 and September 2005 ($n = 34$), 20 perforations (two-stage exposed) occurred (eight in the lower jaw, 12 in the upper jaw) in 14 patients. In seven out of these 14 patients, one or more other implants ($n = 20$) healed uneventfully (two-stage submerged). To compare early exposed with submerged implants, the latter implants were scored too.

Data of another 20 consecutive implants (eight in the lower and 12 in the upper jaw), placed following a one-stage surgical protocol (one-stage) in nine patients, were also selected. No patients were treated with both two- and one-stage procedures. Intra-patient outcome for the one-*versus* the two-stage procedure could not be compared.

Of the 23 patients included in this study only three were smokers (Table 1).

Radiographs

Digital intra-oral radiographs (Dentsply/Gendex®, Chicago, IL, USA) were taken, with a strict paralleling technique, at implant placement, and after abutment surgery for the two-stage exposed and two-stage submerged group or after 3 months for the one-stage group (Fig. 1). Bone loss was measured mesially and distally by an on screen cursor after magnifying the digital radiograph 14x (Visiquick®, Utrecht Dental, the Netherlands). This cursor was calibrated on the known width of the inserted implant, and bone loss was measured with an accuracy of 0.1 mm.

Statistics

For the three treatment groups, mean values and ranges were calculated. For comparison, a generalized linear-mixed model (probability of bone loss) and a linear mixed model (degree of bone loss) were used. Patient was taken as a

Table 1. Overview of data

No. of patients	Smoker	Two stage						No. of patients	Smoker	One stage		
		exposure			submerged					position	boneloss	
		position	boneloss		position	boneloss					mesial	distal
			mesial	distal		mesial	distal					
1	0	46	1.9	2.5	36	0	0.3	15	0	14	0	0.4
2	0	34	1.2	1.6	35	0	0			15	0	0.3
					36	0	0	16	0	15	0.2	0.9
3	0	36	1	1	34	0	0			14	0	0
		46	1.6	2	35	0	0			13	0.3	0.5
					45	0	0	17	0	14	0	0
4		24	0	2	25	0	0			15	0	0
					26	0	0	18	0	16	0	0.2
					13	0	0	19	0	15	0	0
					14	0	0			16	0	0
					15	0	0	20	0	35	0	0
5	1	26	2.8	3.3	25	0	0			36	0	0
					24	0	0			37	0	0
					14	0	0	21	0	45	0.8	0
					15	0	0	22	0	45	0	0
6	0	15	1.9	2.1	14	0	0			46	1.3	0.5
					24	0	0			24	0	0
					25	0	0			25	0	0
7	0	15	2.8	2.5	46	0.1	0	23	0	45	0	0
					36	0	0			46	0	0
8	0	45	2	1.7								
9	0	45	1.7	1.9								
10	0	35	1.9	2.1								
11	0	25	1.6	2								
12	0	23	0.4	1.9								
		24	1.7	2.6								
		25	2.3	2.4								
13	1	25	2	2.2								
		26	2	1.7								
14	1	13	2.2	2.7								
		14	1.5	1.6								
		45	3.2	2.7								
Mean		1.79	2.13		0.01	0.02	Mean		0.13	0.14		
SD		0.6	0.51		0.02	0.07	SD		0.33	0.25		

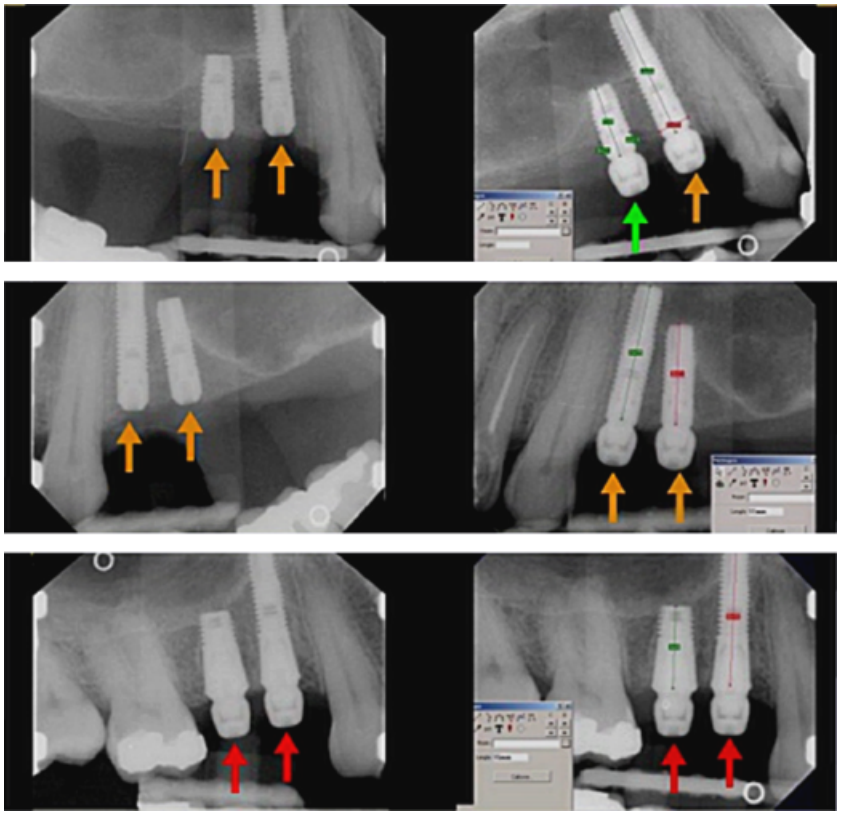

Fig. 1. Radiographs taken at implant placement and after abutment connection (2-stage implants), or after three months (1-stage implants). Orange arrow: 2-stage submerged, green arrow: 2-stage exposed, red arrow: 1-stage.

random factor. Correction for simultaneous hypothesis was performed according to Tukey–Kramer.

Intra-patient comparisons (patients with both exposed and submerged implants) were performed by a two-tailed *t*-test using average bone loss per patient and condition.

Results

Mean bone re-modelling during the first 3–4 months after implant insertion was 1.96 mm (range: 0.2–3.2 mm) around two-stage exposed implants, 0.01 mm (range: 0.0–0.3 mm) around the two-stage submerged implants, and 0.14 mm (range: 0.0–1.2 mm) around the one-stage implants. This amount of bone loss was significantly higher ($p < 0.05$) in the two-stage exposed group compared with the other two groups. The differences between two-stage submerged and one-stage, between the lower jaw and the upper jaw were not significantly different ($p = 0.44$).

Intra-patient comparison (perforation *versus* two-stage submerged) again showed significantly more bone loss for the early exposed implants.

Discussion

This case series thus indicates that when soft tissue integrity is not maintained during the healing phase of a two-stage submerged implant, significantly more bone loss will occur when compared to a one-stage approach and a two-stage submerged healing.

Spontaneous perforation of the gingival tissues coronal of implants can be caused by acute or chronic mechanical trauma of prosthetic devices or failure of primary wound closure due to tension in the flaps. Moreover, a supra-crestal location of the implant head can result in irritation and perforation of the mucosa; the latter was however not the case in our patients.

Bone loss after unintentionally exposed implants in the oral cavity could be explained by a bacterial infection that arises almost instantly. The biofilm that contains *Prevotella* species, *Streptococcus beta-hemoliticus*, and *Fusobacterium* species (Barboza et al. 2002) among others can prevent bone apposition and/or can induce bone loss in the area adjacent to the infection (Persson et al. 2001). Another explanation could be the creation of a sufficient biological width, defined as the soft tissue barrier of approximately 3 mm separating the bone from the oral cavity (Buser et al. 1992, Abrahamsson et al. 1996, 1997, Cochran et al. 1997, Hermann et al. 1997). The latter is unrelated to function and occurs whether the implant is loaded or not (Tal et al. 2001). In this report, unintentionally exposed implants lose around 2 mm marginal bone. The diameter of the exposures never exceeded the width of the implant and consequently a horizontal component (above the cover screw) of the soft tissue should be added to the vertical component (marginal bone loss).

Perhaps the pressure from the removable denture on the soft tissue and/or on the integrating implant could also explain the increased bone loss along the exposed implants. In our patients the risk for such a pressure has been reduced to a minimum by putting the implants below the bone crest and by placing a soft liner in the denture. However, one can of course never exclude such an interference for 100%.

This peri-implant bone loss after unintentional exposure was also described by Tal et al. (2001) for Brånemark implant. This bone loss thus appears independent of the implant surface. They found a correlation between the degree of exposure and bone loss. For hardly detectable perforations (Class I), the bone loss was less than for perforations where the cover screw was visible (Classes II, III, IV). A statistically significant difference could not be found between the last three classes.

In light of the present findings and the report by Tal et al. (2001), one could consider placing an (healing) abutment as soon as a perforation is diagnosed to avoid further bone loss. After placing an (healing) abutment the mucosa is supported and raised by the abutment to a dimension that may reach the dimension of the biological width. In a beagle dog model, mandibular pre-molars were replaced after a healing time by implants (Berglundh & Lindhe 1996). In conjunction with traditional abutment connection, the volume of the ridge mucosa was maintained on one side, while on the contra-lateral side the

vertical dimension of the soft tissue was reduced to about 2 mm. At sides where the ridge mucosa before abutment connection was thin ($\leqslant$2 mm), wound healing consistently included bone resorption to establish a mucosa–implant attachment that was circa 3 mm high. Our results assume that for unintentional perforations, where initially the biological width is not respected, bone loss during initial healing allow the creation of a sufficiently large biological width.

It can be speculated, in patients with a very thin biotype, to place the implants subcrestally or to place the implants in one stage. Several studies have already proven that one-stage surgery has no negative impact on the bone level compared with the two-stage approach (Collaert & De Bruyn 1998, Cecchinato et al. 2004, Engquist et al. 2005). In this study, early bone loss was less in the two-stage group compared with the one-stage group, but the difference was not statistically significant. This minimal bone loss is due to re-modelling, which will start in the the two-stage group after abutment connection. Furthermore, Cecchinato et al. (2004) found no differences in the marginal bone level between the one-stage and two-stage procedures for Astra Tech® implants after 1 year.

Conclusion

Early exposure of an implant during submerged healing results in a significantly higher bone loss compared with one- and two-stage submerged implants. After diagnosing an unintentional implant exposure, it may be useful to consider placing an (healing) abutment to prevent further bone loss. The latter has to be clinically confirmed.

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Address:
Nele Van Assche
Department of Periodontology
Catholic University Leuven
Kapucijnenvoer 33
3000 Leuven
Belgium
E-mail: nele.vanassche@uz.kuleuven.ac.be

Clinical Relevance

Scientific rationale for the sudy: As bone loss was often diagnosed for exposed submerged implants, a comparative study (one-stage, two-stage exposed, two-stage submerged) was performed to investigate the importance of this event.

Principal findings: A significant relationship was observed between bone loss and early perforation of the overlying mucosa. On the other hand, no statistical significant difference was found for bone loss between the one- and two-stage submerged implants over a period of 3 months.

Practical implications: Once an exposure is observed during the healing of a two-stage submerged implant, the placement of a healing abutment may prevent further bone loss. In patients with a thin biotype, a one-stage approach might prevent such an early bone loss.