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Influence of keratinized tissue on spontaneous exposure of submerged implants: classification and clinical observations

TO CITE THIS ARTICLE
Mendoza G, Reyes JD, Guerrero ME, De La Rosa-G M, Chambrone L. Influence of keratinized tissue on spontaneous exposure of submerged implants: classification and clinical observations. J Osseointegr 2014;6(3):47-50.

ABSTRACT

Aim The reasons for spontaneous early exposure (SEE) of dental implants during healing have not been established yet. The objective of this study was to assess whether the width of keratinized tissue (KT) and other site-related conditions could be associated with implants' SEE.

Materials and methods Data from 500 implants placed in 138 non-smoking patients, between September 2009 and June 2010, were evaluated. Implants were submerged and allowed to heal for 3 to 6 months. At baseline, the following conditions were documented: the presence of keratinized tissue width > 2 mm; the type of implant site (i.e. fresh extraction socket or edentulous alveolar ridge); concomitant use of guided tissue regeneration. During the healing period, the occurrence of partial or total implants SEE was recorded; thus, a mixed-effects logistic regression analysis was performed to investigate the association between implant site conditions and implant exposure.

Results One hundred and eighty-five implants (37.0%) remained submerged after healing and were classified as Class I, whereas 215 (43.0%) showed partial spontaneous early exposure (SEE) at the first week after implant placement (Class II), and 100 implants (20.0%) developed more extensive exposures (Class III). The variables, baseline width of KT ($p = 0.18$), fresh extraction socket ($p = 0.88$) and guided tissue regeneration (GTR) plus bone substitutes ($p = 0.42$), were not found to be correlated with implants` SEE, with an odds ratio (OR) of 1.29 (95% confidence interval: -0.12–0.63), 1.03 (95% confidence interval: -0.46–0.53) and 1.22 (95% confidence interval: -0.29–0.68), respectively.

Conclusion It was not possible to establish an association between SEE and some implant-related factors; therefore, further investigations focused on the reasons associated to implants' SEE are needed.

KEYWORDS Dental implants; Guided tissue regeneration; Implants exposure classification; Keratinized tissue width.

INTRODUCTION

Osseointegration is defined as the achievement of a direct bone deposition on dental implant surfaces at the light microscopic level (1). Due to their biocompatible nature, titanium dental implants have been used as a feasible option in the treatment of completely or partially edentulous patients (1, 2). It has been demonstrated that the installation of dental implants may be performed according to one-stage or two-stage protocols (1-6). With respect to the latter, the placement is performed according to the manufacturer's recommendations in order to allow healing (i.e. osseointegration of the implant) in a submerged manner. However, spontaneous early exposure (SEE) of implants during the osseointegration phase may occur (7). Such an unexpected outcome is not desirable, as the patients may not be able to perform an adequate hygiene of the implant site. Partial implants' SEE can create a focus for dental biofilm accumulation, leading to an inflammatory response of the tissues (7). It is well established that the formation of biofilm and the succeeding growth and metabolism of bacteria on the peri-implant sulcus are the key triggers for the initiation of inflammatory lesions in the adjacent mucosa (8-10), as well as peri-implant infection, marginal bone loss, and loss of osseointegration (11-13).

It has been suggested that the presence of a width of keratinized tissue (KT) > 2 mm may allow improved gingival health when the implants are installed (14,15). Moreover, it should be considered that when KT is present in the area where a dental implant is placed, it could help protecting the implant from masticatory trauma, infections and peri-implant bone loss during

healing (7,15). Thus, the objective of this study was to assess the influence of predictive factors, like the width of KT, and other site related conditions, such as implant placement in a fresh extraction socket and guided tissue regeneration plus bone substitutes, on implants' SEE.

MATERIAL AND METHODS

Study population

The dental records of 138 (287 male and 213 female) healthy, non-smoking patients (30 to 60 years) who attended the dental implants clinic of the university (San Martin de Porres University, Lima, Peru) between September 2009 and June 2010 were reviewed. These subjects were selected among patients who were referred for treatment at the university and had received at least one dental implant (range 1 to 11). The areas selected for implant treatment were fresh extraction sockets or edentulous alveolar ridges. All patients who met these criteria were included. Patients with a history of repeated abscess formation, a known systemic disease (e.g., acquired immunodeficiency syndrome, uncontrolled diabetes mellitus, or other established medical risk factors for periodontal disease), or poor hygiene levels were not included in the study. The study protocol was approved by the San Martin de Porres University (Lima, Peru) Ethics on Research Board, in accordance with the Helsinki Declaration of 1975, as revised in 2000, and all subjects signed an informed consent form.

Implants placement

A total of 500 external hex dental implants (Restore® Lifecore Biomedical, Chasca, USA), after a healing period of 3 to 6 months, were evaluated. Following initial examination, maxillary and mandibular casts were obtained and temporary removable partial dentures (e.g. flippers) were fabricated. All patients received detailed information about the planned treatment and underwent oral hygiene instruction; moreover, full-mouth supragingival prophylaxis and/or subgingival scaling of natural teeth were indicated. Following these procedures, patients underwent implants placement following the manufacturer's recommendation (i.e. placed at the level of the crestal bone), and osseointegration was allowed in a submerged manner for three (mandible) or six months (maxilla). Fresh extraction sites were completely covered by coronally advanced flaps, as well as bone grafts were used when the distance between the socket walls and the implant surface was > 2 mm. Additionally, after sutures removal (eight days after surgery) temporary removable partial dentures were delivered and adequately fitted to protect the implant sites.

Outcome measures

Immediately, after implant placement, the width of keratinized tissue (as the distance from the top of the submerged implant to the mucogingival junction) was recorded by two examiners (G.M. and J.D.R.) using a PC-UNC 15 style periodontal probe (intra-class correlation within and between examiners > 0.90). The measurements were rounded to the nearest 0.5 mm. After implants installation, the following characteristics were also recorded:

1) type of implant site (i.e. fresh extraction socket or edentulous alveolar ridge);
2) concomitant use of guided tissue regeneration associated with bone substitutes (i.e. xenografts);
3) occurrence of partial or total implants' SEE during the healing period (from implants' installation to sutures removal).

Classification of SEE

Spontaneous exposure of implants during the healing period was classified into the following three categories:

- Class I, implants remained covered until the second stage surgery (Fig. 1);
- Class II, implants were partially exposed, independently to the degree of partial exposure of the cover screw, to the oral environment before the second stage surgery (Fig. 2);
- Class III, implants were completely exposed and a second stage surgical procedure for the placement of the healing screw was not necessary (Fig. 3).

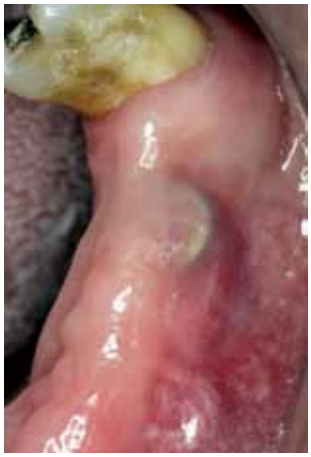

FIG. 1 Class I (implant not exposed).

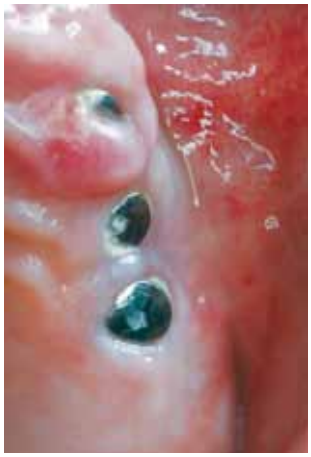

FIG. 2 Class II (includes different degrees of partial exposure).

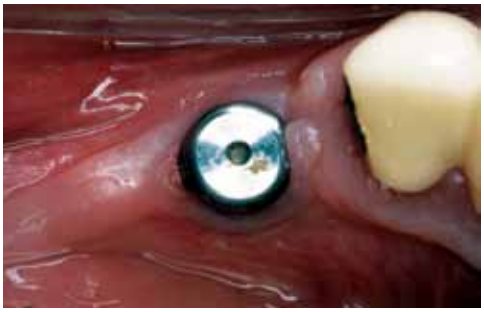

FIG. 3 Class III (implant completely exposed).

	OR	SE	Z	P>|Z|	95% CI	
Fresh extraction socket	1.03	0.25	0.14	0.88	-0.46	0.53
Guided tissue regeneration	1.22	0.25	0.79	0.42	-0.29	0.68
Baseline Keratinized tissue	1.29	0.19	1.33	0.18	-0.12	0.63

TABLE 1 Multivariable mixed-effects logistic regression analysis estimating the association between implant exposure and implant site characteristics. OR: odds ratio CI: confidence interval S.E= standard Error, Z= value calculated by logistic regression model

Statistical analysis

The number and percentages of implants classified according to the different classes were used to synthesize collected data. A mixed-model logistic regression analysis was performed to investigate the association between baseline width of KT, as well as the type of implant site (i.e. alveolar ridge or fresh extraction socket) and the use of GTR plus bone substitutes, with implants` SEE. Thus, such a version of logistic regression was chosen to appropriately account for clustered data. The binary dependent variable was the occurrence of partial or total implant exposure during osseointegration, in order to assess potential factors that might identify the implant sites that were more likely to experience SEE. The Estimated Mixed-Effects Logistic Regression Model was based on the following formula: Model For Implant_exposure = N [-.213884315408148 + 3.69797024563258E02*(fresh_extraction_socket="Y")+199304493013437*(guided_tissue_regeneration="Y")254808035344482*(initial_keratinized_tissue_width="Y")]. Moreover, an odds ratio (OR) with a 95% confidence limit was calculated. A significance level for rejection of the null hypotheses was set at $\alpha = 0.05$. The analysis was performed using a software package (NCSS 2007, Number Cruncher Statistical System, Kaysville, UT, USA).

RESULTS

Of the 500 implants included in the study, 185 (37.0%) remained unexposed at the end of the healing period, and were classified as Class I, 215 (43.0%) presented partial SEE (Class II) and 100 (20.0%) showed complete SEE (Class III). In a follow- up of 3 years only 3 implants were lost; thus, the implant survival rate was 99.4%. The results of the logistic regression analysis are shown in Table 1. The variables were not found to be correlated with implants` SEE, with an odds ratio (OR) of 1.29 (95% confidence interval [CI]: -0.12–0.63) for baseline width of KT (p = 0.18), 1.03 (95% CI: -0.46–0.53) for fresh extraction socket (p = 0.88) and 1.22 (95% CI: -0.29–0.68) GTR plus bone substitutes (p = 0.42).

DISCUSSION

In this case series, almost half of the inserted dental implants (63.0%) showed partial SEE during the healing period. This is in line with a study conducted by Tal (7) in 1999, who identified possible potential risk factors associated with implants` SEE. In the present study, the influence of site-based independent variables (i.e. width of KT, type of implant site and use of GTR plus bone substitutes) was estimated with logistic regression analysis, but none of them showed statistically significant correlation (p > 0.05).

With respect to the high rate of SEE reported in the present study, it could be argued that such an outcome could be linked to some factors, such as the quality of the suture, flap tension and use of releasing flaps to cover implants. The natural contraction of the flap during healing should be taken into consideration (16-18). Also, it is well established that successful tissue flap coverage includes lack of flap tension, as well as complete approximation of wound margins for the correct establishment of an adequate blood supply in order to maintain wound closure and allow primary wound healing (16-18).

Submerged implants protocols assume that implants have to remain covered during osseointegration. Functional difficulties as well as loss of coronal bone support, when implants are exposed in the initial healing period, have been described (7), and, in addition, it was demonstrated that implants that remained covered or totally exposed during the healing process undergo less bone loss. As this correlation has not been studied before and correct clinical decisions during the healing process could prevent inflammation and plaque accumulation, the present study proposes a new classification to help the clinician to choose the best option. It is important to highlight that another important clinical aspect for peri-implant soft tissue integration is the amount of KT (14,15). From a clinical point of view, implants placed in areas of KT width < 2 mm and with a "thinner periodontal biotype" may experience greater SEE. In this study, the logistic regression analysis failed to support the first assumption. In contrast, Bouri et al. (19) reported association between narrow zones of KT and alveolar bone loss around dental implants. Similarly, Crespi et al. (20) reported that in their study narrow zones of KT are less resistant to inflammation and may stimulate apical migration of gingival tissues, inducing marginal recessions.

Even tough, the use of osseointegrated dental implants has become a gold standard procedure for the replacement of teeth lost by for several reasons (21), dental plaque formation and the subsequent

accumulation and metabolism of bacteria on these surfaces is the main trigger for the induction of inflammatory lesions in the adjacent mucosa (8, 13, 22). Therefore, it is also worthwhile to highlight the importance of post surgical plaque control and regular follow up during the healing period (9, 13). Quite often patients with SEE do not follow a regular follow up and show an inadequate dental biofilm control, when they come back for the surgical re-opening of implants. Thus, these factors may have contributed to SEE, as well. Furthermore, if an implant is partially exposed, it should be fully exposed to avoid biofilm accumulation. Given the case series study design limitations, the results of this study are not externally valid. Also, other implant-related sites, that were not included in the statistical model of this retrospective assessment, should have been taken into consideration, such as the presence of teeth adjacent to the implant sites and measurements on the depth (thickness) of the keratinized tissue. For instance, single implant sites with intact teeth on either side would undergo less trauma than multiple implants without the protection of nearby teeth. With respect to the KT thickness, this might be more important than the width, since it seems logical that thick tissues would resist to SEE better than thin periodontal biotype tissue. However, both conditions were not recorded at the time of implants' placement.

Additionally, it could be argued that the present findings may be considered of low clinical significance, given that modern procedures in implant dentistry are mainly based on non-submerged approaches. Despite the absence of strong associations between absence/presence of keratinized mucosa and peri-implant health, it is recommended to maximize efforts to preserve existing keratinized mucosa during the treatment procedures. There is a lack of evidence supporting the concept that grafting procedures aiming at increasing the amount of keratinized mucosa improve outcomes of implant therapy.

CONCLUSION

Within the limitations of this case series study, it can be concluded that implants` SEE is a common outcome during the period of osseointegration of two-stage implant approaches; however, a direct association with precise risk factors could not be established, thus, further researches are needed on this field.

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