

Implant therapy in partially edentulous, periodontally compromised patients: a review

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Abstract

Aim: The purpose of the present study was to perform a review using a systematic approach to evaluate the long-term (≥ 5 years) success of implants placed in partially edentulous patients with a history of periodontitis as evidenced by loss of supporting bone and implant loss.

Material & Methods: An electronic search of the National Library of Medicine, Washington DC (Medline-PubMed) was performed using specific search terms to identify studies assessing, in periodontitis patients, the success of implants with regard to bone level outcomes. Search was performed on abstracts registered up to October 2003.

Results: The searches identified 877 abstracts. Titles and abstracts were independently screened by two reviewers (G.A.W. & K.M.B.) to identify publications that met the inclusion criteria. Review of these abstracts resulted in 13 publications for detailed review. These papers were reviewed by the three authors. Finally four papers which met the criteria of eligibility were independently selected by the three reviewers.

Conclusion: Based on the limited data, it seems justified to conclude that the outcome of implant therapy in periodontitis patients may be different compared to individuals without such a history as evidenced by loss of supporting bone and implant loss.

Keywords: bone level; implants; periodontitis; success rate

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During the last two decades dental implants have become increasingly used as an alternative to conventional removable dentures. A number of clinical studies have indicated that implant therapy has a favourable long-term prognosis (for a review see Berglundh et al. 2002). The high clinical survival rate even in partially edentulous patients has led to a widespread acceptance and use of oral implants. Although the general impression of implant therapy is that the success rate is high, problems do occur. Factors such as bone quality, surgical trauma or bacterial contamination during implant surgery have been associated with early failures (Esposito et al. 1998). Overload, defined as a situation in which the functional load applied to the implants exceeds the capacity of the bone-implant interface to withstand it, is another possible cause

of implant failure, once the prosthesis is installed. Factors associated with late failures of implants are less well understood and seem to be related to both the peri-implant environment and host parameters (for review see Quirynen et al. 2002).

It has been reported that the microbiota associated with peri-implantitis corresponds to that observed at sites with advanced periodontitis and it has been suggested that periodontal pathogens present in the periodontal pockets of teeth may colonize newly inserted implants and give rise to tissue breakdown (Leonhardt et al. 1993). In partially edentulous patients, microorganisms in periodontal pockets may act as a reservoir for colonization of the subgingival area around implants (for review see, Mombelli 2002, Quirynen et al. 2002) and implants with peri-

implantitis in partially edentulous patients have been demonstrated to more frequently harbor *Actinobacillus actinomycetemcomitans*, *Porphyromonas gingivalis* and *Prevotella intermedia* compared with successful implants (Leonhardt et al. 1999).

Periodontitis is considered to be a multifactorial disease (Page et al. 1997). Genetic factors may however explain as much as 50% of the disease (Michalowicz et al. 2000). Susceptible individuals are thought to react more intensively on an infectious agent resulting in a more advanced tissue breakdown (Page et al. 1997). It may therefore be reasonable to anticipate that the risk of peri-implant infections is higher in patients with a previous history of periodontal disease. This may be especially apparent if the periodontal disease is not controlled at the time of implant

installation. It could result in an impaired success rate of implant treatment in this particular patient population.

The purpose of the present study was to perform a review using a systematic approach to evaluate the long-term (≥ 5 years) success of implants placed in partially edentulous patients with a history of periodontitis as evidenced by loss of supporting bone and implant loss.

Material and Methods

The National Library of Medicine, Washington DC (Medline-PubMed) was searched for publications. A broad search directed towards studies on implant treatment in patients with a known history of periodontal disease was performed. The primary outcome variable was change in bone level and the secondary outcome variable was loss of implants.

Eligibility criteria

- (a) Controlled clinical trials and uncontrolled clinical studies.
- (b) Studies of at least 5 years follow-up

The following factors were recorded to be able to investigate heterogeneity of outcome across studies:

- (a) Evaluation period
- (b) Number of subjects
- (c) Mean age and age-range of subjects
- (d) The definition of a 'periodontal patient'
- (e) Implant-system used
- (f) General health
- (g) Smoking habits (defined as smokers, former smokers and non-smokers)

Search strategy

The database was searched up till October 28, 2003 using the following terms for the search strategy:

1. *Implants [All Fields] AND ("Periodontitis" [MeSH Terms] OR Periodontitis [Text Word]).*
2. And a second search with the following search criteria: *Dental implants, single tooth or Dental Implants or coated materials biocompatible or Osseointegration or Denture, partial, fixed or Dental Implantation [MeSH Terms] OR Implants [Text Word] AND Periodontitis or Juvenile Perio-*

odontitis or Periodontal disease or Periodontal diseases or Periodontal Attachment loss or Alveolar bone loss [MeSH Terms] OR Periodontitis or Periodontal disease or Periodontal diseases [Text Word] AND Longitudinal studies.

Screening and selection

The titles and abstracts of the papers were screened by two independent reviewers (G.A.W. & K.M.B.).

The search criteria used to include the papers for full-text screening were:

- implant treatment
- periodontally compromised patients
- partially edentulous patients
- clinical trials with a follow-up period of at least 5 years
- implant loss and/or bone level as outcome variables

When an abstract included the above-mentioned criteria or if there was doubt regarding one or more of the search criteria, the paper was selected for full reading. If any of these criteria was not fulfilled the paper was disregarded. Titles without abstracts, which appeared to be investigating the success rate of implants were selected for full-text reading. Only papers written in the English language were selected. Case reports, letters and reviews were excluded.

The papers selected by the two reviewers were then screened by the three authors independently. Disagreement regarding inclusion was resolved by discussion between the reviewers.

Results

Search results

In October 2003 the database of Medline-PubMed was searched for titles that contained the search terms. Search 1 resulted in 681 titles and search 2 resulted in 683 titles. Out of these 487 were duplicates, leaving 877 papers for review. After screening the titles and abstracts 13 full papers were selected for full-text reading. These papers were read by the reviewers which left finally four articles which fulfilled the selection criteria. The other nine papers were excluded because the evaluation period was < 5 years (Ellegaard et al. 1997), of lack of information about bone-level (Papaioannou et al. 1995), or contained patients with no history of periodontitis (Linkow & Kohen 1979, Block et al.

1996, Gouvoussis et al. 1997, Quirynen et al. 2001). There were also two case reports (Balshi 1992, Nevins & Gartner-Sekler 1997) and one editorial (Newman 1998).

Study quality

Of the four selected papers only two papers compared the success of implants in periodontitis and non-periodontitis patients (Hardt et al. 2002, Karoussis et al. 2003). The remaining studies evaluated the success rate of implant placement in periodontitis patients only (Mengel et al. 2001, Leonhardt et al. 2002). All four studies presented radiographic data about bone level.

Hardt et al. (2002) presented implant failure rate, Leonhardt et al. (2002) the survival rate while Karoussis et al. (2003) used success rate based pre-determined values for peri-implant probing depth and annual bone loss. With regard to success-rate, Mengel et al. (2001) refer to the criteria formulated for the Brånemark-implants using the Kaplan-Meier survival curve (Albrektsson et al. 1986);

- absolute immobility of the implant abutment
- no radiographically detectable peri-implant osteolytic zones
- no inflammation, pain or paresthesia
- vertical bone loss of < 0.20 mm from the second year onwards
- a success rate of 85% after 5 years and of 80% after 10 years.

Outcome

The selected papers are summarized in Tables 1 and 2.

Table 1 provides a short summary of the study design and certain descriptive aspects of the patient population. The evaluation period varied from 5 to 11 years post implant placement and the number of subjects involved from 5 to 53. The diagnosis of a 'periodontitis patient' varied between the studies making comparisons between studies difficult.

Table 2 presents the results of the selected papers. Due to lack of uniformity in the way the data are presented in the papers the results can only be regarded separately.

Leonhardt et al. (2002) studied longitudinally two-stage implants in patients who had been treated for advanced periodontitis before the start of the study. The patients had been carriers of

Table 1. Selected studies, follow up time and patient characteristics

Study	Participants	Follow-up in years	Smoking habits	General health	Definition of periodontitis
Mengel et al. (2001)	$n = 5$ (♀ = 5) Age range: 31–44 years	5	Not reported	No systemic diseases	General aggressive periodontitis. Progressing in spite of surgical treatment and antibiotics.
Leonhardt et al. (2002)	$n = 15$ (♀ = 7, ♂ = 8) Age range: 21–71 years	10	Not reported	Not reported	Patients treated for advanced periodontal disease
Hardt et al. (2002)	Perio, $n = 25$ (♀ = 13, ♂ = 12) Age: 53.5 years Non-Perio, $n = 25$ (♀ = 16, ♂ = 9) Age: 57.3 years	5	Not reported	No systemic diseases	Periodontitis defined as an age related bone loss score. % teeth with bone level <50% at baseline: Perio = 25.7%, Non-Perio = 1.1%
Karoussis et al. (2003)	Perio, $n = 8$ Non-Perio, $n = 45$	10	Perio = 47.6% implants in smokers Non-Perio = 19.8% implants in smokers	Not reported	History of periodontitis

putative periodontal pathogens and were carriers of these species at the 10-year examination. The 54 fixtures followed showed a mean bone loss of 1.7 mm (± 1.2 mm) and 61% of the implant sites showed bleeding on sulcus probing. The mean bone loss around the examined natural teeth during the observation period was 0.8 mm (± 1.5 mm) with 35% of the sites showing bleeding on probing. The survival rate for implants was 94.7%.

In the paper by Mengel et al. (2001) a distinction was made between aggressive and chronic periodontitis. Only for the aggressive periodontitis group are 5-year data reported while the chronic group was followed for 3 years. Using a two-stage implant system the bone loss at 5-years post surgically in the aggressive periodontitis was on average 0.88 mm. Bone loss at the implants in the first 3 years after insertion of the final abutment was significantly higher in the generalised aggressive periodontitis patients as compared to patients diagnosed as having chronic periodontitis. The 5-year implant survival/success rate was 88.8%.

Only two papers (Hardt et al. 2002, Karoussis et al. 2003) compare implant placement in periodontitis and non-periodontitis patients. The Karoussis et al. (2003) paper uses a population that consists of treated periodontitis patients as compared with non-periodontitis patients. Periodontitis was defined as individuals who had their teeth lost because of periodontitis, and non-periodontitis patients had their teeth lost due to other reasons (caries, fracture

or trauma) or agenesis. The results indicate that the periodontitis group (PG) are more susceptible to peri-implantitis evidenced as bone loss is greater than the non-periodontitis control group (NPG). The incidence of complications (peri-implantitis) reported by Karoussis et al. (2003) was 28.6% in the PG patients and 5.8% in the NPG patients. If clinical success was defined as probing depth ≤ 5 mm and a negative bleeding on probing and bone loss $< 0.2\%$ annually, the PG demonstrated a 52.4% and the NPG a 79.1% success rate. Survival rate for the PG was 90.5% while for the NPG it was 96.5%.

In the paper by Hardt et al. (2002) the patients were divided in accordance to an age-related bone loss score (ArB-score). The two-tail quartiles were defined as either a periodontitis (PG) or non-periodontitis group (NPG). Implant loss and bone loss were more prominent in PG as opposed to NPG. In all, 64% of PG patients had a mean peri-implant bone loss of > 2 mm from the time of abutment connection, compared with 24% for the NPG patients ($p < 0.01$). Using multiple regression on the total number of patients ($n = 97$) a significant relationship ($p = 0.029$) was found between ArB-score and the implant bone level change over 5 years. The 5-year survival rate was 92% in the PG patients and 97% in the NPG patients.

Discussion

There is still a debate on whether the long-term prognosis of implants is as

good in partially edentulous periodontally compromised patients as has been observed in long-term studies in the general population. It has been suggested that implants placed in partially edentulous patients are more at risk for bacterial colonization with a perio-pathogenic micro-flora emerging from the periodontal pockets around diseased teeth in the same mouth (Meffert 1993, Nevins 2001). Leonhardt et al. (1993) proposed that partially edentulous patients with titanium implants will easily be colonized by putative periodontal pathogens in contrast to fully edentulous patients. However, if a destruction of the marginal bone around the implants occurs, this does not seem to be solely related to the presence of a perio-pathogenic microflora. It is rather the result of a complex interaction between the microorganisms and host factors, similar to what has been seen around natural teeth affected with destructive periodontitis.

Accordingly a past history of periodontitis may represent a significant risk factor for complications around implants in patients that have been treated for advanced periodontitis. Untreated periodontal disease and refractory periodontitis patients are at risk for complications and a regular maintenance program is essential to keep the periodontal and peri-implant tissues healthy (Leonhardt et al. 1993). Consequently, it has been suggested that patients should not be subjected to dental implant therapy if they present with local inflammation or inadequate oral hygiene (Buser et al. 1999).

Table 2. Selected studies; Results regarding implants

Study	# Implants at baseline	Implant loss	Implant system	Gingival health	Plaque	Bone loss in mm	Loss of attachment	Success rate %	Survival rate %	Comparison implants/natural teeth
Mengel et al. (2001)	<i>n</i> = 36	<i>n</i> = 4	Brånemark	0.5 GI	0.8 PI	0.88	Between 1st and 5th year 3.6 mm	88.8% in function	88.8% in function	More loss of clinical attachment (<i>p</i> < 0.001) at implants
Leonhardt et al. (2002)	<i>n</i> = 57	<i>n</i> = 3	Brånemark	61% BOP	In 7 out of 15 patients	1.7 ± 1.2	Not reported	Not reported	94.7%	More bone loss around implants
Hardt et al. (2002)	Perio <i>n</i> = 25 Non-Perio <i>n</i> = 25	Perio <i>n</i> = 8 Non-Perio <i>n</i> = 3	Brånemark	Not reported	Not reported	Perio = 2.2 ± 0.8 Non-Perio = 1.7 ± 0.8	Not reported	Not reported	Perio = 92% Non-Perio = 96.7%	Not reported
Karoussis et al. (2003)	Perio <i>n</i> = 21 Non-Perio <i>n</i> = 91	Perio <i>n</i> = 2* Non-Perio <i>n</i> = 4*	2* ITI Hollow screw	Not reported	Not reported	Perio mesial = 1.00 ± 1.38 distal = 0.94 ± 0.73 Non-Perio mesial = 0.48 ± 1.10 distal = 0.50 ± 1.08	Not reported	Perio = 52.4% [†] Non-Perio = 79.1% [†]	Perio = 90.5% Non-Perio = 96.5%	Not reported

*Calculated by author.

[†]Success rate over 10 years using 5 mm as borderline for PPD and annual bone loss < 0.2 mm.

Evidence based dentistry uses the best evidence available to decide on suitable options for clinical application. Such evidence comes from different types of studies conducted in various patient groups. The process involves searching the literature to capture all evidence about the question of interest. The main question of this review article was whether a history of periodontitis has an effect on the long-term prognosis of implants. Only one prospective paper was found reporting on implants placed in patients treated for periodontal disease as compared to implants inserted in non-periodontitis patients (Karoussis et al. 2003). Of the selected papers this study represents the highest level of evidence. However, the classification of periodontitis used in this paper may be argued and the number of patients in the periodontitis group is very limited. On the other hand this study and data from a retrospective comparison (Hardt et al. 2002) with a larger group of patients classified as periodontitis patients, based on alveolar bone loss, suggest that “periodontitis patients” are more likely to develop complications around their implants. Although at a lower level of evidence this conclusion is further supported by the two uncontrolled studies describing only the success of implants in “periodontitis patients” (Mengel et al. 2001, Leonhardt et al. 2002).

Smoking is a risk factor for periodontal disease and it is reported that smoking will also affect the success of implant placement (Lindquist et al. 1996, Ekfeldt et al. 2001, Leonhardt et al. 2003). Wilson and Nunn (1999) found an increased risk for implant failure by a factor of almost 2.5 among smokers. Smoking status was however not always reported in the selected studies. Karoussis et al. (2003) divided both periodontitis and non-periodontitis patients in a smoker and non-smoker group. In patients in the periodontitis group, 47.6% of the implants were installed in smokers. This was 19.8% of the implants in the patients without a history of periodontitis. It should however be recognized that the periodontitis group consisted of 8 patients only. The remaining selected papers did not provide information regarding the patients smoking status.

The review intended to use both decrease of the bone level and loss implants as outcome variables. Evaluating the bone level around implants may

be considered as an earlier parameter describing long-term stability and success as compared to complete loss of the implant. Since bone loss has to be measured on radiographs, care should be taken in defining reference points for duplicate measurements. The availability of different implant systems put further emphasis on this. Only two out of selected papers provided information about standardisation of the radiographs taken (Hardt et al. 2002, Karoussis et al. 2003). All papers defined the reference point used for bone level measurements.

The present review identified four papers evaluating the success of implants in partially edentulous patients with a previous history of periodontitis. A major concern for this review and others to come is the definition of the 'periodontitis patient'. What signs and symptoms must be present in any specific individual in order to justify categorizing this specific individual as a 'periodontitis patient'? Periodontal disease present at a specific site or on a tooth level basis can be defined. But how is an individual defined as a 'periodontitis patient'? Should a 'periodontitis patient' have four pockets with bleeding upon probing, or perhaps six such pockets? Do such individuals require a certain number of areas with attachment or bone loss? Others yet may stress the importance of furcation involvement, or a certain level of bleeding on probing or presence of specific microorganisms. Another aspect to be considered is the success of periodontal treatment. Is this the absence of pocket > 5 mm, absence of bleeding upon probing or even the absence of specific microorganisms? Or is success the registered stability of the attachment level over a number of years?

Perhaps until the periodontal community clearly defines what is meant by 'a periodontitis patient', there is continued scope for confusion when questions like the one put forward in the present paper are aimed to be answered.

Due to the discrepancies of parameters between the included studies, the relatively low number of individuals involved in three of the four papers, and the variation in what is considered a 'periodontitis patients', makes it difficult to reach a firm statement. The limited data indicate that the outcome of implant therapy in periodontitis patients may be different compared to individuals without such a history as eviden-

ced by loss of supporting bone and implant loss.

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