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ScienceDirect
British Journal of Oral and Maxillofacial Surgery xxx (2011) xxx–xxx
BRITISH Journal of Oral and Maxillofacial Surgery
www.bjoms.com

Early dental implant failure: risk factors

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Accepted 8 April 2011

Abstract

The objective of this prospective study was to estimate the incidence of early loss of dental implants and the potential risk factors. The predictive variables were classified as being patient, implant, anatomical, or operation-specific. The outcome variable was early failure of the implant. The significance of differences was assessed using bivariate analyses, and then a multivariate logistic regression model to identify independent predictors for early loss of implants. A total of 169 patients, 116 women and 53 men, mean age 47 (range 16–80) years, had 399 implants inserted. Fifteen implants were lost in 14 patients (8%). The early loss of dental implants was significantly associated with width of keratinised gingiva ($p = 0.008$), the use polyglactin sutures ($p = 0.048$), and the use of narrow implants ($p = 0.035$). Multivariate logistic regression analysis established the significance of narrow keratinised gingiva (OR = 4.7, $p = 0.005$) and the use of polyglactin sutures (OR = 3.8, $p = 0.042$), which we conclude are probably the strongest predictors of early failure of implants.

Keywords: Dental implant; Early failure; Risk factors

Introduction

A revolution in the research and technology of implants during the last two decades has made the replacement of missing teeth with endosseous implants the standard care, and an implant-supported prosthesis is the first line of treatment and long-lasting rehabilitation.[1] The criteria that define the success of dental implants have been changing continuously, and currently include the absence of mobility at the start of the prosthetic phase,[2] the absence of continuing radiolucency around the implant,[3] the absence of peri-implantitis with suppuration, and subjective complaints from the patient.[3,4]

Failure of endosseous implants is either early or late, depending on whether it occurs before or after occlusal loading with a prosthetic superstructure.[5] Most failures occur early, so the recognition of potential risk factors of early failure is important.[6] Clinical studies have identified the following: quality and volume of bone, site, and grafted bone, as well as systemic factors such as genetic predisposition, smoking, and metabolic disorders.[7]

The aim of this prospective study in a teaching hospital was to investigate the potential risk factors that lead to early failure of endosseous implants.

Subjects and methods

Design of study

We designed a prospective clinical observational study of patients referred to the Oral and Maxillofacial Surgery Division at the University of Jordan Hospital between March 2006 and March 2010. Patients listed for replacement of a single missing tooth or more, with implants, were included in this study. Patients with uncontrolled metabolic disease or osteonecrosis were excluded. Threaded, grit-blasted, and acid etched implants were used from two manufacturers: Xive (Dentsply-Friadent, Mannheim, Germany) and ITI (Strau-

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doi:10.1016/j.bjoms.2011.04.074

Please cite this article in press as: Baqain ZH, et al. Early dental implant failure: risk factors. *Br J Oral Maxillofac Surg* (2011), doi:10.1016/j.bjoms.2011.04.074

mann, Waldenburg, Switzerland). A treatment plan was prepared by the surgeon and a prosthodontist after they had evaluated the patient's history; alveolar availability at the edentulous sites was evaluated by an orthopantomograph or computed tomogram (CT). All patients were operated on by a single consultant surgeon and, as this was a study of early failure of dental implants, we made no evaluation of the prosthetic treatment or after starting the prosthetic treatment.

All procedures were done according to a standard protocol. Local anaesthesia was by local infiltration (2% lignocaine with 1:100,000 adrenaline) following which a mucoperiosteal flap was raised. Co-amoxiclav 625 mg was given orally 1 h before operation, and the course continued for 5 days postoperatively. Patients who were allergic to penicillin were given clindamycin 150 mg every 6 h for 5 days. All patients were prescribed chlorhexidine digluconate rinse postoperatively twice a day for 7 days.

All implants followed the protocol of either 1 or 2 operation(s): non-submerged or submerged implants. The latter was our standard practice and the former was adopted when a shorter treatment time was preferable. When bone was needed to cover exposed threads, autogenous cancellous bone was used. In cases of augmentation of the horizontal or vertical ridge, corticocancellous blocks were harvested, usually from intraoral sites. For external raising of the sinus floor, alloplastic or allogeneic bone was used mixed with autogenous bone. Insertion of implants was postponed until the bone had regenerated satisfactorily. Internal raising of the sinus floor was done at the same time as the implants were inserted if a bone graft was not used. Flaps were closed with polyglactin 910 or black silk sutures, alternating between patients. The implants were evaluated from the time of their placement until reopening (second operation) for the submerged, or starting prosthetic treatment for the non-submerged, implants. An implant was considered a failure if peri-implant radiolucency was detected on intraoral radiographs, if there were signs or symptoms of infection, or if there was the slightest movement when the implant was tested by feeling at the time that the cover screw was removed.

Variables and statistical analysis

The predictive variables for the study were classified as patient, implant, anatomical, and operative-specific. Variables specific to patients included: age, sex, smoking habits, and general health (history of hypertension, ischaemic cardiac disease, gastric problems, osteoporosis, hypothyroidism or hyperthyroidism, hypercholesterolaemia, asthma, and diabetes type I or II). Anatomical variables included: site of implant, width of the keratinised gingiva (measured with a periodontal probe), and quality of bone. Variables specific to the implant were its length and diameter. Operative variables included: timing and method of placement, use of a bone graft, internal sinus lift, type of suture used, and intraoperative complication (lack of primary stability by tactile assessment, fracture, perforation, or dehiscence of the jaw). The outcome variable was the failure of an implant as a result of lack of osseointegration.

Data were collected on a form designed for this study, and then entered into a spreadsheet on a PC; forms with incomplete data were excluded ($n = 27$). Statistical analysis was computed with the help of the Statistical Package for the Social Sciences for Windows (version 17, SPSS Inc., Chicago, IL, USA). Descriptive statistics were calculated, and bivariate analyses using the chi square test and Student's t test for independent samples were used to assess the significance of differences between the predictive variables and outcome. Fisher's exact test was used when only two subgroups were being compared because the expected numbers of patients with failed implants within subgroups were so small. Probabilities of less than 0.05 were accepted as significant.

Forward stepwise multivariate logistic regression analysis was then used to control for potential confounding variables and to calculate the odds ratios (OR) and 95% CI for potential independent predictors of outcome. Biologically relevant variables (age and sex) and variables that had probabilities of less than 0.20 in the initial analyses were entered into the logistic regression model as independent variables.

Results

The study group comprised 169 patients ranging in age from 16 to 80 years (mean (SD) 47 (16) years). There were 53 men (31%) and 116 women (69%). These patients were given a total of 399 implants, with a mean of 2.4 implants/patient. Of the total number inserted, 15 (4%) in 14 patients failed to osseointegrate. Distributions among patients of the variables studied and their relation to outcome are shown in Tables 1–4.

Three variables were significantly associated with the outcome of implants in the univariate analysis: the presence of narrow attached gingiva ($\leq$2 mm) at the site of insertion ($p = 0.008$) (Table 2); the use of polyglactin sutures ($p = 0.048$) (Table 3); and narrow implants (<3.5 mm) compared with medium (3.5–4.5 mm) or wide (>4.5 mm) ($p = 0.04$) (Table 4). Multivariate logistic regression analysis (Table 5) confirmed the importance of the width of keratinised gingiva and the type of suture material used as independent predictors of the failure of implants. Implants inserted in areas of narrowly attached gingiva had nearly five times the risk of early failure (OR = 4.7, $p = 0.005$), and the use of polyglactin sutures was associated with a nearly four times higher risk of early failure (OR = 3.8, $p = 0.04$).

Discussion

Early failure of dental implants is thought to be caused by failure of bony healing around the implant and subsequent failure of osseointegration; this could be attributed to local or systemic factors.[1,8] Despite using well-documented dental

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Table 1
(a) and (b) Patients' variables and their relation to failure of the implant (15 implants in 14 patients).

(a)

Variables	Outcome of implant		
	Total ($n = 169$)	Failed ($n = 14$)	
	No (%)	No	p-Value
Sex			0.77
Female	116 (69)	9	
Male	53 (31)	5	
Smoking			0.27
No	140 (83)	10	
Yes	29 (17)	4	
Chronic morbidity			0.54
No	121 (72)	9	
Yes	48 (28)	5	

(b)

	Total ($n = 169$)	Failed implant ($n = 14$)	
		No	Yes
Age (years)			
Mean	47	47	49
SD	16	16	15
Range	16–80	16–80	18–76

implant systems, the possession of adequate clinical experience, the use of measures to avoid cross infection, and the adequacy of soft and hard tissues, implants could fail early after insertion. The reported early failure rate is from 0.7% to 3.8%.[1,5,6,9,10] The incidence of early failure of implants in this study was 4%, partly attributed to the nature of cases referred to the university hospital.

A narrow keratinised gingiva was significantly associated with early loss of implants, and to our knowledge no studies have been published that considered its width and early failure. There is no consensus about this, and a recent review found no evidence to support a relation between the width of keratinised tissue and survival of implants.[8] However, other studies have shown that a thin or absent masticatory gingiva was associated with bleeding on probing and a significantly greater mean loss of alveolar bone.[11] Despite the widespread use of absorbable, multifilament, synthetic sutures in oral surgery (as they cause little reaction in tissues compared with other suture materials),[12] our results showed that the use of polyglactin 910 was associated with a higher incidence of early loss of implants ($p = 0.048$) than silk sutures. The latter is a non-resorbable, natural, braided material that is preferred by some surgeons because it is easy to handle; it has good tension and stability for the duration of suture, and is also

Table 2
Anatomical variables and their relation to failure of the implant.

	Total ($n = 399$)	Failed ($n = 15$)	
	No (%)	No	p-Value
Width of attached gingiva (mm)			0.008
≤2	111 (28)	9	
>2	288 (72)	6	
Site of implant			0.61
Upper anterior	64 (16)	2	
Upper posterior	136 (34)	7	
Lower anterior	37 (9)	2	
Lower posterior	162 (41)	4	
Dentition			1.00
Partially edentulous	361 (91)	14	
Fully edentulous	38 (10)	1	
Type of bone			0.24
1	14 (4)	1	
2	184 (46)	7	
3	151 (38)	3	
4	50 (13)	4	

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Table 3
Operative variables and their relation to failure of implants.

Variables	Total ($n = 399$)	Failed implants ($n = 15$)	
	No (%)	No	p-Value
Timing of implant			0.96
Immediate	56 (14)	2	
Post-immediater	34 (9)	1	
Delayed	309 (77)	12	
Method of insertion of implant			0.22
Non-submerged	44 (11)	3	
Submerged	355 (89)	12	
Bone graft			0.97
None	286 (72)	11	
Cancellous[a]	61 (15)	2	
Corticocancellous blocks[b]	43 (11)	2	
Alloplastic/allograft[c]	9 (2)	0	
Internal raising of sinus floor			0.13
No	365 (92)	12	
Yes	34 (9)	3	
Type of suture material			0.048
Silk	176 (44)	3	
Polyglactin 910	225 (56)	12	
Intraoperative incident			0.13
No	382 (96)	13	
Yes	17 (4)	2	

[a] Fragments collected from the drills or extracted from the maxillary tuberosity.
[b] Implants inserted into previously grafted areas.
[c] Mixed with cancellous bone for external raising of sinus floor.

Table 4
Variables specific to implants and their relation to failure.

	Total ($n = 399$)	Failed implants ($n = 15$)	
	No (%)	No	p-Value
Diameter of implant (mm)			0.035
<3.5	85 (21)	7	
3.5–4.5	268 (67)	7	
>4.5	46 (12)	1	
Length of implant (mm)			0.78
Short (<10)	80 (20)	4	
Medium (10–12)	216 (54)	7	
Long (>12)	103 (26)	4	

known for the acute inflammatory reaction that it triggers.[13] However, a recent in vivo study showed that silk was less likely to support bacterial colonisation than other suture materials, which minimises the chance of developing odontogenic infection.[14]

A recent study described the largest early loss of implants with short and narrow implants.[10] We also found that the loss of implants was more common with narrow implants (<3.5 mm) ($p = 0.035$); shorter implants were also more likely to be lost, but not significantly so. One possible explanation is that narrow and short implants are usually placed in areas in which there is limited space or insufficient volume of bone.

Reported co-existing medical conditions seem to have a variable effect on the success of implants. We found that early loss was more common among patients with such conditions, but not significantly so. Despite the suggestion that type 2 diabetes has a possible adverse effect on survival of implants,[7] there is no conclusive evidence. A recent review showed that cardiovascular diseases did not contribute to the early failure of implants,[1] though it is widely accepted that

Table 5
Stepwise logistic regression model for failure of implants.

Variable	Regression coefficient	p-Value	Odds ratio	Confidence intervals for odds ratio
Constant	−6.164	0.000	0.002	
Width of attached gingiva ≤ 2 mm	1.544	0.005	4.685	1.606–13.667
Polyglactin suture material	1.344	0.042	3.833	1.047–14.027

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smoking has an adverse effect on their survival and success.[6,7] However, tobacco alone cannot be considered a risk factor for early failures.[15] There is evidence to suggest that smoking may have a dose-related effect on osseointegration,[5] but those authors did not account for the number of cigarettes that patients smoked each day.

The periodontal and endodontic state of neighbouring teeth has to be taken into consideration when inserting implants.[5] The loss of one implant in this study was attributed to failed root canal treatment in the adjacent tooth. Higher failure rates were reported when implants were inserted next to neighbouring teeth than implants in an edentulous ridge.[5] Although a slightly higher rate was noted in this study (4% compared with 3%) the difference was not significant.

It has been suggested that type 4 and 1 bones are more likely to fail,[5] and we found similar findings. It has been speculated that the inability to establish intimate bone-implant contact compromises bone healing, which in turn leads to fibrous union and failure.[5,16] This applies where there is lack of primary stability and when the integrity of the bony socket is violated. Despite a higher early failure rate being reported when an intra-operative incident had occurred, the difference was not significant.

It is important to take account of the fact that the total number of complications was low, which makes definitive pronouncements difficult. Under these circumstances our results suggest that the lack of keratinised gingiva and the use of polyglactin sutures may be strong predictors of the early failure of implants. More studies are required to assess the effect of increasing the width of attached gingiva, and to compare monofilament with braided sutures.

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