Original Article

The Risk Factors in Early Failure of Dental Implants: a Retrospective Study

Hassan Mohajerani [1], Roozbeh Roozbayani [2], Shahram Taherian [3], Reza Tabrizi [1]

[1] Dept. of Oral and Maxillofacial Surgery, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
[2] Dental Student, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
[3] Fellowship of Oral and Maxillofacial Implantology, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

KEY WORDS
Dental Implants;
Risk Factor ;
Osseointegration;
Dental Implantation;

Received November 2016;
Received in Revised form February 2017;
Accepted October 2017;

ABSTRACT

Statement of the Problem: Despite the low failure rate of dental implants, recognition of the risk factors can enhance the predictability of failure.

Purpose: The aim of this study was to evaluate the risk factors for early implant failure.

Materials and Method: This retrospective cohort study was conducted on two groups of patients, the patients with a failed implant before loading and those without a failed implant. Age, gender, implant type, implant surface, implant length, bone type, type of surgery (one- or two-stage) and immediate (fresh socket) or delayed placement of implant were the variables to be assessed in this study.

Results: Out of the 1,093 evaluated implants, 73 cases (6.68%) failed in early stages. The two groups were significantly different in terms of implant surface, fresh socket placement, prophylactic use of antibiotics, and bone density ($p< 0.05$). Age, gender, implant height, implant type (cylindrical or tapered) and one-stage or two-stage placement were not significantly different between the two groups ($p> 0.05$).

Conclusion: It seems that prophylactic antibiotic therapy, implant surface, bone density and placement in fresh extraction socket may contribute to dental implant failure.

Corresponding Author: Tabrizi R., OMFS ward, Shahid Beheshti Dental School, Velenjak, Tehran, Iran. Email: tabmed@gmail.com Tel :+98-2126802783

Cite this article as: Mohajerani H., Roozbayani R., Taherian Sh., Tabrizi R. The Risk Factors in Early Failure of Dental Implants: a Retrospective Study. *J Dent Shiraz Univ Med Sci.,* 2017 December; 18(4): 298-303.

Introduction

Endosseous dental implants are successfully used to replace the missing teeth. Despite the predictability of success of dental implants, a small group of patients may experience implant failure. Success of dental implants depends on the site of implant placement, the patient's conditions, surgeon's experience, the precision of surgical technique, and type of implants. [1] Failure of endosseous dental implants may occur prior to occlusal loading with a prosthetic superstructure or later after loading. [2] Based on chronological criteria, the biological failures can be classified into "early failures" (due to unsuccessful osseointegration, indicating impaired bone healing) and "late failures" (due to loss of osseointegration). [3-4] Several factors may be associated with early implant failure such as smoking, implant characteristics, infection, and insufficient bone quality/quantity. [5] Recognition of risk factors can reduce the failure rate and increase the predictability of dental implant treatment.

The purpose of this study was to assess the possible factors responsible for early failure of dental implants. It was hypothesized that age, gender, implant surface and height, no prophylactic use of antibiotics, type of surgery (one-stage or two-stage), fresh socket placement, and bone quality may be associated with high failure rate of dental implants.

Materials and Method

This retrospective cohort study recruited samples deriv-

ed from the population of patients presenting to the Oral and Maxillofacial Surgery Department of Shahid Beheshti University of Medical Sciences between September 1, 2008 and October 31, 2015. The research protocol was approved by The Committee of Medical Ethics of Shahid Beheshti University of Medical Sciences.

The subjects eligible for the study had a missing tooth and received dental implant treatment. The exclusion criteria were having a systemic disease affecting the bone healing, history of bone grafting, jaw fracture, or radiotherapy, previous implant failure, and smoking.

The dental implants were studied in two groups of patients; group 1 consisted of the patients with a failed implant before loading and group 2 included those without failed implant.

The implant surface was classified into four categories; sandblasted and acid-etched (SLA), resorbable blast media (RBM), calcium phosphate-coated, and OsseoSpeed surface (Dentsply-Astra Tech; Sweden). The types of implants were studied in two groups of cylindrical implants and tapered implants. The implant height was studied in two groups of L1 comprising of patients who received an implant shorter than 10 mm and L2 comprising of patients who received implants of ≥10-mm length.

The bone quality was categorized into four types as D1, D2, D3, and D4 based on the Lekholm and Zarb classification. [6] The two types of implant surgery were studied as one-stage in patients who received a tissue level implant and two-stage in patients who received a bone level implant. The patients were studied in two groups as those who received prophylactic antibiotic therapy (2 grams of amoxicillin one hour before surgery) and those who did not receive prophylactic antibiotic therapy.

Regarding the age range, the patients were evaluated in age groups of 20-40, 41-60 and over 60 years.

The time of implant placement was evaluated in two groups of fresh socket placement and delayed placement for implants placed more than three months after tooth extraction.

Age, gender, implant type, implant surface, implant height, bone type, type of surgery, and immediate (fresh socket) or delayed placement of the implant were the variables of the study. Success or failure of the implants was the outcome of this study.

Statistical Analysis

The statistical analyses were performed by using SPSS software, version 19 (SPSS Inc.; IL, USA). Chi-Square test was used to compare the variables between the two groups. Moreover, the Shapiro-Wilk test was applied to determine whether the sample data were drawn from a normally distributed population or not.

Results

A total of 1,093 implants were evaluated in this study, out of which, 73 cases failed in early stage (6.68%). In terms of the implant surface, failure occurred in 42 out of 624 implants (6.7%) with SLA surface, 19 out of 61 RBM implants (31.1%), 10 out of 341 calcium phosphate coated implants (2.9%) and 2 out of 67 OsseoSpeed implants (3%). (Table 1) The four types of implant surface showed significantly different failure rates ($p< 0.001$).

Table 1: Comparison of implant surfaces between the two groups

Group	SLA	RBM	Calcium phosphate coated	Osseo Speed	Chi square test
Group 1	42	19	10	2	$p= 0.001$
Group 2	582	42	331	65	

Regarding the type of implant, failure was observed in 37 out of 629 cylindrical implants (5.9%) and 36 out of 464 tapered implants (7.8%). Analysis of the data revealed no significant difference between the cylindrical and tapered implants in this regard ($p= 0.22$, Table 2). Reviewing the implants failure based on the implant length revealed that 32 out of 476 implants (6.7%) with length of less than 10 mm and 41 out of 617 implants (6.6%) with length of ≥10 mm length failed. Comparison of the failure rate between implants shorter than 10 mm and those ≥10mm length did not reveal any significant difference ($p= 0.53$).

The implant failure was also checked based on the types of implant surgery. The results represented that 14 cases of 317 one-stage implants (4.4%) and 59 cases of 776 two-stage implants (7.6%) failed (Table 2). The difference between the failure rate of one-stage and two-stage implants was not significant ($p= 0.61$). Gender-related comparison of the failure rate showed that 24 of 388 males (6.2%) and 49 of 705 females (7%) experienced implant failure (Table 2). However, the two genders had no significant difference in failure rate ($p=0.71$).

Table 2: Comparison of variables between the two groups

Variables	Group1	Group 2	Chi-Square test
Implant type	37 CY,38 TP	592 CY,428 TP	*p*= 0.22
Implant length	32 L1, 41 L2	444 L1, 576 L2	*p*= 0.53
Surgery type	14 OS,59 TS	303 OS,717 TS	*p*= 0.61
Gender	24 M,49 F	364M , 656 F	*p*= 0.71
Immediate or delayed placement	26 FR,47 DL	71 FR,949 DL	*p*= 0.001
Prophylactic Antibiotic therapy	48 PA,25 WPA	989 PA,31 WPA	*p*= 0.001

CY: Cylindrical TP: Tapered L1:< 10 mm L2:≥ 10 mm OS: One-stage TS: Two-stage M: Male F: Female
FR: Fresh Socket DL: Delayed WPA: Without prophylactic antibiotic therapy PA: prophylactic antibiotic therapy

Failure was also observed in 47 of 975 delayed implants (2.7%) and 47 of 118 fresh-socket implants (39.8%) (Table 2). The difference of failure rate between the two groups was statistically significant, with the fresh socket group being far more susceptible to failure (*p*= 0.001).

Reviewing the relationship between the bone quality and implant failure, it was found that 13 of 260 implants (5%) placed in D1 bone, 12 of 534 implants placed in D2 bone (2.2%), 23 of 169 implants placed in D3 bone (13.6%), and 25 of 130 implants placed in D4 bone failed (19.2%) (Table 3). Evaluation of the data showed a significant difference in failure rate among different bone types (*p*= 0.001).

Table 3: Evaluation of the frequency of various bone types between the two groups

Group	D1	D2	D3	D4	Chi-square test
Group 1	13	12	23	25	*p*= 0.001
Group 2	247	522	146	105	

Table 4: Evaluation of age ranges in the two groups

Group	20<-<40 years	40<-< 60 years	60<years	Chi-square test
Group 1	19	36	18	*p*= 0.88
Group 2	240	526	254	

Implant failure was also assessed in relation with the patient's age range. In this regard, implant failure was reported in 19 of 259 patients in the age range of 20-40 years (7.3%), 36 of 562 patients in the age range of 40-60 years (6.4%), and 18 of 272 patients (6.6%) in the age range of over 60 years. The implant failure rate was not significantly different among different age groups (*p*= 0.88). In patients who received prophylactic antibiotic therapy, 48 of 1037 implants failed (4.6%) and in the group who did not receive prophylactic antibiotic therapy, 25 of 56 implants failed (44.6%). As was noted, implant failure rate was significantly higher in the patients who did not receive prophylactic antibiotic therapy (*p*= 0.001, Table 4).

Discussion

Recognition of the potential risk factors in early implant failure may help decreasing the frequency of failure and prevent early implant loss. Early failures occur due to the inability to establish a close contact between the bone and implant, absence of bone apposition, and formation of fibrous tissue between the implant surface and the surrounding bone. [7] Loss of osseointegration is clinically detected by implant mobility, and radiologically confirmed by peri-implant radiolucency. [7]

Infection and impaired healing are the two major mechanisms responsible for dental implant failure. Bacterial infection may cause implant failure and can occur at any time during the implant treatment, but it is quite important in early healing period. Impaired healing may be due to the surgical trauma (insufficient irrigation, overheating), micro-motions, and the patient's related local and systemic factors, which play an imperative role in dental implant failure related to impaired healing. [8]

The surface of dental implants is a key factor in bone-implant contact and the speed of bone apposition around the implants. [9] Among the four surface types evaluated in this study, the highest failure rate was noted in RBM series and the lowest in calcium phosphate coated implants.

Hong *et al.* [10] compared four different implant surfaces in the tibia of dog and reported the average bone-implant contact ratio to be 95.4% in hydroxyapatite-coated (HA) group (*p*< 0.01), 87.1% in RBM group (*p*< 0.05), and 86.0% in SLA group. They concluded that osseointegration was superior in HA-coated implants compared with other groups. Ahmed *et al.* [11] stated that implants with RBM or SLA surface had comparable survival rates in short-term and the SLA surface seemed to be superior in the posterior maxilla

with poor bone quality.

Kim *et al*. [12] studied the survival rate of RBM and calcium phosphate coated implants, and found no significant difference between them. They only announced that calcium phosphate coated implants provided favorable clinical results. The higher rate of failure in the current study might be due to other factors such as technical errors, various implant brands with RBM surface which had different designs and manufacturing process, and implant selection (type) in different occasions. [12]

The tapered implants have higher primary stability and provide superior clinical results than cylindrical implants. [13] In the present study, the failure rate was statistically similar between the tapered and cylindrical implants. There is no clinical evidence supporting the higher survival rate of tapered or cylindrical implants. [14]

The one-stage approach is preferred in partially edentulous patients since it does not require a second surgical intervention and has a shorter course of treatment; Whereas, a two-stage submerged approach can be used when optimal primary stability is not achieved or when guided tissue regeneration is indicated. [15] This study did not demonstrate any significant difference between one-stage and two-stage procedures. Nor did previous studies mention any difference in the survival rate between the submerged and non-submerged implants. [16-17]

Earlier placement of implants with the highest feasible length is advocated. The longer implants are believed to exhibit higher survival rate and more favorable prognosis. [18] Several recent studies showed that placement of short implants was not a less efficacious treatment option compared to the placement of implants with ≥10-mm length in totally or partially edentulous patients. [19-20]

The primary stability of dental implants highly relies on the bone density. [21] Higher failure rate was reported in D4 bone. [22] The present study found the highest and lowest failure rate in D4 and D2 bones, respectively. The two controversial points to considered in evaluation of bone quality are the reliability of surgeons' perception of bone quality during the surgery (which is difficult to evaluate), as well as the fact that the bone quality is the same as bone density if no specific definition has been provided for bone density. [23]

Fresh socket implant placement has been declared as a risk factor for higher failure rate. [24] Peñarrocha-Diago *et al*. [25] reported that the survival rate of dental implants placed in fresh extraction sockets was similar to that of dental implants placed in mature bone. Immediate implants placed in the posterior maxilla often have a higher failure rate. [25] The present study showed a higher failure rate in implants placed in fresh socket.

Age is considered as a prognostic factor in implant success. The older patients have a longer healing time, systemic health risk factors, and relatively poor bone conditions. [26] Predictability of dental implants in elderly patients has been declared in several studies. [27-28] The current study noted no difference in the failure rate among various age groups. Moy *et al*. [29] reported that older age was strongly associated with higher implant failure rate. Most previous studies reported no relation between the age and gender and early implant failure. [30-32]

Prophylactic use of antibiotics can reduce the failure rate of dental implant treatment. [33] Sharaf *et al*. [34] suggested the prophylactic use of a single dose of antibiotic in dental implant treatment. Esposito *et al*. [35] studied the efficacy of prophylactic antibiotics in placement of dental implants in a pragmatic multicenter placebo-controlled randomized clinical trial. Their results did not prove the efficacy of prophylactic antibiotics in decreasing the failure rate.

Our results showed a higher failure rate in patients who did not receive prophylactic antibiotics (44.6% versus 4.6% in patients who received prophylactic antibiotic). Gynther *et al*. [36] reported no advantage to the antibiotic prophylaxis in routine dental implant surgery. Morris *et al*. [37] suggested little or no advantage to supporting antibiotic coverage for dental implant placement.

Since the implant failure has multifactorial etiology, determination of all factors needs a large sample size and strict control on variables. Several variables, which were not studied in this study, could be considered as limitations of this study including the experience of the operators, the patient's nutritional status, and oral hygiene status before and after the implant placement, drilling speed, use of dull drills, as well as the indications and parameters for selection of the type and techn-

ique.

Since smoking was proved as a risk factor for dental implant survivals, [38] the current study excluded smokers to determine other risk factors without any cross-effect precisely. In bone graft cases, many variables interfere with the outcome of treatments such as bone substitutes, soft tissue coverage, type of membranes, and delayed or immediate dental implant placements. Further studies are recommended to address the above-mentioned variables.

Conclusion

Within the limitations of this study, it can be concluded that prophylactic antibiotic therapy, implant surface, bone density and fresh socket placement of implants might contribute to the dental implant failure.

Conflict of Interest

The authors of this manuscript certify that they have no conflict of interest.

References

[1] Porter JA, von Fraunhofer JA. Success or failure of dental implants? A literature review with treatment considerations. Gen Dent. 2005; 53: 423-432.

[2] Baqain ZH, Moqbel WY, Sawair FA. Early dental implant failure: risk factors. Br J Oral Maxillofac Surg. 2012; 50: 239-243.

[3] Manor Y, Oubaid S, Mardinger O, Chaushu G, Nissan J. Characteristics of early versus late implant failure: a retrospective study. J Oral Maxillofac Surg. 2009; 67: 2649-2652.

[4] Sakka S, Baroudi K, Nassani MZ. Factors associated with early and late failure of dental implants. J Investig Clin Dent. 2012; 3: 258-261.

[5] Olmedo-Gaya MV, Manzano-Moreno FJ, Cañaveral-Cavero E, de Dios Luna-del Castillo J, Vallecillo-Capilla M. Risk factors associated with early implant failure: A 5-yearretrospective clinical study. J Prosthet Dent. 2016; 115: 150-155.

[6] Branemark PI, Zarb GA, Albrektsson T, Rosen HM. Tissue-integrated prostheses osseointegration in clinical dentistry. Plast Reconstr Surg. 1986; 77: 496–497.

[7] Esposito M, Hirsch JM, Lekholm U, Thomsen P. Biological factors contributing to failures of osseointegrated oral implants: (II). Etiopathogenesis. European Journal of Oral Sciences. 1998; 106: 721–764.

[8] Sakka S, Coulthard P. Implant failure: etiology and complications. Med Oral Patol Oral Cir Bucal. 2011;16: e42-e44.

[9] Sartoretto SC, Alves AT, Resende RF, Calasans-Maia J, Granjeiro JM, Calasans-Maia MD. Early osseointegration driven by the surface chemistry and wettability of dental implants. J Appl Oral Sci. 2015; 23: 279-287.

[10] Hong WS, Kim TH, Ryu SH, Kook MS, Park HJ, Oh HK. Comparative study of osseointegration of 4 different surfaced implants in the tibia of dogs. J Korean Assoc Oral Maxillofac Surg. 2005; 31: 46-54.

[11] Elkhaweldi A, Lee DH, Wang W, Cho SC. The survival rate of RBM surface versus SLA surface in geometrically identical implant design. J Oral Bio. 2014; 1: 8-15.

[12] Kim HK, Lee EY, Kim JJ. Five-year retrospective radiographic follow-up study of dental implants with sandblasting with large grit, and acid etching-treated surfaces. J Korean Assoc Oral Maxillofac Surg. 2015; 41: 317-321.

[13] De Rouck T, Collys K, Cosyn J. Immediate single-tooth implants in the anterior maxilla: a 1-year case cohort study on hard and soft tissue response. J Clin Periodontol. 2008; 35: 649-657.

[14] O'Sullivan D, Sennerby L, Meredith N. Influence of implant taper on the primary and secondary stability of osseointegrated titanium implants. Clin Oral Implants Res. 2004; 15: 474-480.

[15] Esposito M, Grusovin MG, Chew YS, Coulthard P, Worthington HV. Interventions for replacing missing teeth: 1- versus 2-stageimplant placement. Cochrane Database Syst Rev. 2009 Jul 8;(3):CD006698.

[16] Astrand P, Engquist B, Anzén B, Bergendal T, Hallman M, Karlsson U, et al. Nonsub-merged and submerged implants in the treatment of the partially edentulous maxilla. Clin Implant Dent Relat Res. 2002; 4: 115-127.

[17] Cecchinato D, Olsson C, Lindhe J. Sub-merged or non-sub-merged healing of endosseous implants to be used in the rehabilitation of partially dentate patients. J Clin Periodontol. 2004; 31: 299-308.

[18] Lee JH, Frias V, Lee KW, Wright RF. Effect of implant size and shape on implant success rates: a literature review. J Prosthet Dent. 2005; 94: 377-381.

[19] Kotsovilis S, Fourmousis I, Karoussis IK, Bamia C. A systematic review and meta-analysis on the effect of implant length on the survival of rough-surface dental implants. J Periodontol. 2009; 80: 1700-1718.

[20] Telleman G, Raghoebar GM, Vissink A, den Hartog L, Huddleston Slater JJ, Meijer HJ. A systematic review of the prognosis of short (<10 mm) dental implants placed in the partially edentulous patient. J Clin Periodontol. 2011; 38: 667-676.

[21] Turkyilmaz I, McGlumphy EA. Influence of bone density on implant stability parameters and implant success: a retrospective clinical study. BMC Oral Health. 2008; 8: 32.

[22] Jaffin RA, Berman CL. The excessive loss of Branemark fixtures in type IV bone: a 5-year analysis. J Periodontol. 1991; 62: 2-4.

[23] Ribeiro-Rotta RF, Lindh C, Pereira AC, Rohlin M. Ambiguity in bone tissue characteristics as presented in studies on dental implant planning and placement: a systematic review. Clin Oral Implants Res. 2011; 22: 789-801.

[24] Khouly I, Keenan AV. Re-view suggests higher failure rates for dental implants placed in fresh extraction sites. Evid Based Dent. 2015; 16: 54-55.

[25] Peñarrocha-Diago M, Demarchi CL, Maestre-Ferrín L, Carrillo C, Peñarrocha-Oltra D, Peñarrocha-Diago MA. A retrospective comparison of 1,022 implants: immediate versusnonimmediate. Int J Oral Maxillofac Implants. 2012; 27: 421-427.

[26] Ikebe K, Wada M, Kagawa R, Maeda Y. Is old age a risk factor for dental implants. Jpn Dent Sci Rev. 2009; 45: 59-64.

[27] Kowar J, Stenport V, Jemt T. Mortality patterns in partially edentulous and edentulous elderlypatients treated with dental implants. Int J Prosthodont. 2014; 27: 250-256.

[28] Garg A. Dental implants for the geriatric patient. Dent Implantol Update. 2011; 22: 49-52.

[29] Moy PK, Medina D, Shetty V, Aghaloo TL. Dental implant failure rates and associated risk factors. Int J Oral Maxillofac Implants. 2005; 20: 569-577.

[30] van Steenberghe D, Jacobs R, Desnyder M, Maffei G, Quirynen M. The relative impact of local and endogenous patient-relatedfactors on implant failure up to the abutment stage. Clin Oral Implants Res. 2002; 13: 617-622.

[31] Alsaadi G, Quirynen M, Komárek A, van Steenberghe D. Impact of local and systemic factors on the incidence of oralimplant failures, up to abutment connection. J Clin Periodontol. 2007; 34: 610-617.

[32] Palma-Carrió C, Maestre-Ferrín L, Peñarrocha-Oltra D, Peñarrocha-Diago MA, Peñarrocha-Diago M. Risk factors associated with early failure of dental implants. A literature review. Med Oral Patol Oral Cir Bucal. 2011; 16: e514-e517.

[33] Sharaf B, Dodson TB. Does the use of prophylactic antibiotics decrease implant failure? Oral Maxillofac Surg Clin North Am. 2011; 23: 547-550.

[34] Sharaf B, Jandali-Rifai M, Susarla SM, Dodson TB. Do perioperative antibiotics decrease implant failure? J Oral Maxillofac Surg. 2011; 69: 2345-2350.

[35] Esposito M, Cannizzaro G, Bozzoli P, Checchi L, Ferri V, Landriani S, et al. Effectiveness of prophylactic antibiotics at placement of dental implants: a pragmatic multicentre placebo-controlled randomised clinical trial. Eur J Oral Implantol. 2010; 3: 135-143.

[36] Gynther GW, Köndell PA, Moberg LE, Heimdahl A. Dental implant installation without antibiotic prophylaxis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1998; 85: 509-511.

[37] Morris HF, Ochi S, Plezia R, Gilbert H, Dent CD, Pikulski J, et al. AICRG, Part III: The influence of antibiotic use on the survival of a new implant design. J Oral Implantol. 2004; 30: 144-151.

[38] Strietzel FP, Reichart PA, Kale A, Kulkarni M, Wegner B, Küchler I. Smoking interferes with the prognosis of dental implanttreatment: a systematic review and meta-analysis. J Clin Periodontol. 2007; 34: 523-544.