

Early Implant Failure Using Straumann AG Implant System for Fixed Partial Prosthesis

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ABSTRACT

Objectives: To assess early implant failure using Straumann AG dental implant system for fixed partial prosthesis at KHMC and to determine the effect of several potential risk factors on this early failure

Method: All the patients scheduled for partial prosthetic replacement of missing teeth using Straumann AG - SLA dental implants during six months period were included in this study. The following data were recorded for each patient: age, gender, medical history, and smoking habits. Clinical and radiographic examination was performed for each patient prior to the surgical phase of treatment to determine the bone type, site, diameter and length of the implants to be used in addition to the periodontal condition. Patient's related factors that have been investigated as risk for early implant failure include age, gender, smoking, pre-existing periodontitis, and general health, while implant related risk factors include bone type, site, diameter, length of the implants.

Results: During the study period, a total of 366 implants were placed in 158 patients, their mean age of 44.5 years, and females comprised of 64.5%. The majority of the patients were healthy except 18 (11.4%) were medically compromised, 27.8% were smokers, and 25.9% have periodontitis. Out of the total 366 implants, three implants failed (0.81). Smoking, medical health, and periodontitis were significant risk factors in early implant failure ($p < 0.05$).

Implants placed in the maxillary and mandibular arches account for 176 (48.1%) and 190 (51.9%) respectively, with the majority being placed in the posterior sites of both jaws. The dominant bone type was III (53.55%), while the dominant implant length and diameter were 10mm and 4.1mm respectively. None of the local or implant related variables have a significant effect on early implant failure ($P > 0.05$).

Conclusion: This study established that early failure using Straumann AG dental implant system for fixed partial prosthesis was 0.8%, and this early failure was significantly associated with smoking, medical health, and periodontitis.

Key words: Early failure, Fixed partial prosthesis, Risk factors

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Introduction

Replacement of missing teeth has become one of the most important needs for patients attending dental clinics to restore function and/or esthetics.

Many treatment modalities are available for this purpose including fixed or removable prosthesis, and each modality has its indications and contraindications. Branemark in the middle of 1960s established the concept of

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osseointegration, since then, dental implants have gained a high reputation due to their high success rate,⁽¹⁾ even for implants placed in the esthetic zone,⁽²⁾ in block bone graft,⁽³⁾ and in periodontally compromised patients.⁽⁴⁾ The reported overall mean survival rate for 2- to 16-year follow-up was 94.4%.⁽⁵⁾

Despite the long-term success shown by longitudinal, multicenter studies, failure is inevitable. A global failure rate of 1.9% to 3.6% has been reported, and the primary predictors of implant failure that had been reported include: poor bone quality, chronic periodontitis, systemic diseases, smoking, advanced age, implant location, parafunctional habits, loss of implant integration, and inappropriate prosthesis.^(6,7) Implant failure timing can also be used for classification as early failure when occurs before or at abutment connection as a result of failure to establish osseointegration, due to interference with the healing process, and late failure which occurs after a period of function and occlusal loading.⁽⁸⁾ Therefore, excluding immediate loading implants, all failures occurring before prosthesis placement can be categorized in the early group and those occurring after functional loading in the late group.

According to Goodacre *et al.* (2003), early failures in implant-supported FPDs are often associated with implant loss.⁽⁹⁾ Implant loss prior to restoration can be expected on average to be 2.5% of all implants placed with an additional 2-3% lost over the first 5 years of function.⁽¹⁰⁾

To minimize the occurrence of early and late failures, it is mandatory to understand the pathogenesis and risk factors. Risk assessment for implant patient can affect the outcome of a therapeutic intervention by identification variables that increase the risk of complications leading to implant loss. Risk assessment should be performed before placement of implants to avoid high failure rates by identifying suitable candidates for implant treatment, and during the phase of implant placement to identify and avoid technical issues that can affect implant survival.⁽¹¹⁾ Palma-Carrió *et al.* (2011) in their review found that there was a higher percentage of early than late failures; nevertheless, few articles analyzed risk factors associated with early implant failure.⁽¹²⁾

Our experience in dental implantology at King Hussein Medical Center was started in 1995; the present authors published 5-years results (2000-2005) using Straumann AG / SLA implants in posterior maxilla, in which the overall success rate was 96.7%.⁽¹³⁾ The aim of this study was to assess early implant failure using Straumann AG dental implant system at KHMC and to determine the effect of several potential risk factors on this early failure.

Methods

A prospective study was conducted at KHMC during a 6-months period (August 2012 till January 2013) on patients scheduled for prosthetic replacement of missing teeth by partial or full-mouth fixed prosthesis using Straumann AG -SLA dental implants.

Exclusion criterion includes patients with uncontrolled metabolic or psychological disorders, immune-suppression disorders, osteonecrosis, or under chemotherapy or radiotherapy, or with a history of poor compliance or lack of understanding or communication. Poor compliance was assessed through communication with the patient to evaluate his/her view on oral health, the frequency and regularity of dental visits, and the home care procedures. However, none of the patients scheduled for implants during the study period was excluded.

For each patient data were collected on age, gender, dental and medical histories. Clinical and radiographic examination was performed for each patient prior to the surgical phase of treatment and the bone type, site, diameter and length of the implants to be used were determined. Periodontitis data were also obtained from clinical and radiographic evaluation.

All surgical procedures were performed by the same specialist starting with local anesthesia by local infiltration using Septanest® (2% Articaine hydrochloride with 1:100,000 adrenaline), then a muco-periosteal flap was raised and the implants were placed according to the protocol of Straumann AG, (Waldenburg, Switzerland) implant system. Synthetic absorbable braided polyglactin 910 was used for flap closure in all cases. Antiseptic mouth rinsing (0.2% chlorhexidine) was prescribed together with oral systemic antibiotics (Amoxicillin 500mg and

Table I: date of the three failed implants

Patient	Age	Gender	Smoking	periodontitis	Site	Length	Diameter	Bone type	MH
1	68	male	+	+	UP	6	4.1	2	HT
2	48	female	+	+	LP	10	4.1	3	Healthy
3	62	male	+	+	LP	10	4.1	2	HT

*HT: hypertension, UP: upper posterior, LP: lower posterior, MH: medical health

Table II: The significance of early implant failure in relation to the patient's variables

Patient variable	no. (%)	Failure no.(%)	p value
Male	56 (35.5)	2 (3.57%)	0.264
Female	102 (64.5)	1 (0.98%)	not.sig.
Age > 45	75(47.46)	3 (4%)	0.071
Age ≤45	83(52.54)	0	not sig.
Smoking	44 (27.8)	3 (6.81%)	0.006
No history of smoking	114 (72.2)	0	sig.
Periodontitis	41(25.95)	3 (7.3%)	0.004
No history of periodontitis	117 (74.05)	0	Sig.
Medically compromised	18 (11.4)	2 (11.11%)	0.004
Healthy	140 (88.6)	1 (0.71%)	sig.

metronidazole 250mg) three times daily for 5 days postoperatively. In cases required regeneration, a synthetic biodegradable bone material NanoBone® was used as bone graft material, and Guidor® (polylactide) was used as resorbable regenerative membrane. Any complication occurs during the healing period was reported. In areas of reduced alveolar bone height, short dental implants were used, and poor bone quality was compensated by increasing the number and diameter of fixtures.

Risk factors for early implant failure that were investigated were divided into patient related (age, gender, smoking habits, preexisting periodontitis, and general health), and implant related (bone type, site, length and diameter of implant). During the surgical phase, the following incidents were considered as complications: lack of primary stability by tactile assessment, poor wound healing, perforation, or dehiscence of the jaw.

Chi square test was used to analyze the data using SPSS software; p value was considered significant if less than 0.05.

Results

The study consisted of 158 patients ranging in age from 17 to 75 years (mean, 44.53 years). Females were more than males in the study sample comprised (102) 64.5% compared to (56) 35.5% male patients. Ten patients (6.32%) were hypertensive, 6 (3.79%) were diabetic, 1 (0.63%) patient has ischemic heart disease, and 1 (0.63%)

has osteoporosis. Non-smokers were more than smokers comprised 113 (71.5%) and 45 (28.5%) respectively. A total of 366 implants were placed with a mean of 2.3 implant per patient. Three implants were failed out of the 366 implant with a percentage of 0.81%. Table I showed data regarding of the 3 failed implants.

The significance of early implant failure in relation to patients' variables that have been investigated (age, gender, smoking, pre-existing periodontitis, and general health) is presented in Table II. It can be noticed that more early failures occur in males than females, and medically compromised that healthy patients. All the three failed implants occur in patients above 45 years of age who are smokers and with a history of pre-existing periodontitis. However, statistically significant effect on early implant failure was found only for smoking, pre-existing periodontitis, and general health of the patient.

The impact of early implant failure in relation to the implant site, bone type, length and diameter of implant are presented in Table III. The majority of the implants were placed in the mandibular posterior site (46.9%) while the least in mandibular anterior site (4.9%). About 95% of the implants were placed in type 2 and 3 bone. Implants 4.1mm in diameter and 10mm length comprised 74.1% and 61.5% respectively. However, none of these factors has a significant effect on early implant failure.

Lack of primary stability by tactile assessment occurred in one patient at the site of maxillary

Table III: The significance of early implant failure in relation to the implant site, bone type, length and diameter of implant

Site of implant	No. (%)	Failure No. (%)	P value
Maxillary posterior	114 (31.14)	1(0.87)	0.824
Maxillary anterior	62 (16.93)	0	not sig.
Mandibular posterior	172 (46.99)	2(1.16)	
Mandibular anterior	18 (4.91)	0	
Total	366	3 (0.82)	
Bone type			
I	3 (0.81)	0	0.835
II	151 (41.25)	2 (1.32)	not sig.
III	196 (53.55)	1(0.51)	
IV	16 (4.37)	0	
Total	366	3	
Length of implant			
6	18 (4.91)	1(5.55)	0.112
8	119 (32.51)	0	not sig.
10	225 (61.47)	2(0.88)	
12	4 (1.09)	0	
Total	366	3	
Diameter of Implant			
3.3	54 (14.75)	0	0.584
4.1	271(74.04)	3 (1.1)	not sig.
4.8	41(11.2)	0	
Total	366	3	

first molar. The wound healing after one week of the surgery was poor in two patients (one was osteoporotic and the other was diabetic) which necessitate re-suturing. Two cases of jaw perforation occurred in the maxillary anterior region due to the presence of amalgam tattoo close to the site of implant, and the other due to narrow bone. The two cases were treated by guided bone regeneration. All the previously reported complications were healed eventually without any complexity.

Discussion

Over the last decades, dental implants have become a commonly used treatment modality for replacing missing teeth. Early failures often are associated with a disruption that occurs during the initial healing phase, leading to fibrous scar tissue formation between the implant surface and the surrounding bone.⁽¹⁴⁾ Earlier days implant success was evaluated by immobility and peri-implant radiolucency, while currently many factors play a role in evaluating implant success such as the width of the attached gingiva, co-existing medical conditions, smoking, length and width of the implant also.⁽¹⁵⁾ Genetic and immunological markers like TNF- α and IL-1 β

have been identified as markers for implant success.⁽¹⁶⁾

This study aimed to assess early implant failure using Straumann AG dental implant system at KHMC and to determine the effect of several potential risk factors on this early failure. The percentage of early implant failure varies between different studies from 0.7% to 8%.^(7,17-21) In the present study, out of the 366 implants placed, 3 (0.82%) failed prior to loading. Some of the factors that may be attributed to early implant failure such as the operator's experience, different implant designs, changes in the surgical techniques or suture materials were minimized in this research since all cases were performed by the same double-qualified prosthodontist and implantologist, using the same implant system (Straumann AG), and the same surgical technique and materials. Oh *et al.* (2002) in a review of the causes of early implant bone loss found that surgical trauma including heat generation during drilling, elevation of the periosteal flap, and excessive pressure at the crestal bone during implant placement may contribute to implant bone loss during the healing period.⁽²²⁾

Patient's risk factors for early implant failure and have been investigated in this study include age, gender, smoking, pre-existing periodontitis,

and general health. The three failed implants were placed in three patients (one female and two males) who aged above 45 years, smokers, and with pre-existing periodontitis.

Decreased regeneration of bone with increasing age was reported by Shirota *et al.* (1993) suggesting slower bone healing and increased failure rates in older patient.⁽²³⁾ Advanced age was considered by some researchers among primary predictors of implant failure.^(7,18) However, clinical studies found no significant differences in osseointegration between young and old patients.⁽²⁴⁾ The mean age for all participants in the present study was 44.53 years; therefore, patients were divided as less or equal to 45 years and above 45 years, and all the failures occur in the older group of patients. Although early failure was more with increased age and male gender, but the results were not statistically significant. This finding is consistent with a study that was conducted in Jordan to assess risk factors in early implant failures, who found no significant difference with regard to gender.⁽²¹⁾ However, Manor *et al* (2009) found that early failures occurred more in younger women.⁽⁸⁾

It is well-known that smoking has an adverse effect on the survival and success of implant.⁽²⁵⁾ Though smokers comprised only 27.8% of the study population in the present research, the result revealed that smoking is a significant risk factor for early implant failure. The reduced vascularity of bone is considered the predominant mechanism for implant failure in smokers.⁽²⁶⁾ Early implant failure was found by many studies to be significantly related to smoking habits.^(18,25,27) Shibli *et al.* (2010) in a histological study confirmed that smoking has a detrimental effect on early bone tissue response around oxidized implant surfaces.⁽²⁸⁾ However, it was suggested that the impact of smoking may be more important to long-term implants than to early implant failure.⁽²⁹⁾ Radiographic assessment of inter-proximal bone level around implants lasting a minimum of 6 months revealed that smokers are more prone to implant loss.⁽³⁰⁾ On the contrary, other researchers found that tobacco alone cannot be considered a risk factor for early failures.^(19,20)

History of preexisting periodontitis was found to be significantly related to early implant failure in

the present study. Kronström *et al.* (2001) demonstrated that antibody avidity to *B forsythus* and antibody titer to *S aureus* were highly significantly associated with early implant failures.⁽³¹⁾ It is worth noticing that *B forsythus* have shown to be within the mixed flora found in experimentally induced periimplantitis.⁽³²⁾ The consensus report of the 6th European Workshop on Periodontology has confirmed that peri-implant diseases are infectious in nature.⁽³³⁾ Noguero *et al* 2006 found that even though the periodontal status variable did not reach significance in early implant failure, they did not consider its effect to be negligible.⁽¹⁸⁾ However in their study, all patients with periodontitis were previously treated before inserting the implants and they suggest close monitoring to ensure successful osseointegration. Treated periodontitis and proper periodontal maintenance care with a good level of oral hygiene should be considered with the inclusion criteria.⁽³⁴⁾ Neighbouring teeth and contra-lateral teeth and implants have the same susceptibility to recurrence of periodontal disease and peri-implantitis under the same oral conditions, therefore, active maintenance treatment is important for the long-term success of implants for patients treated for periodontal disease.⁽³⁵⁾

The last patient's variable that was found to be significantly related to early implant failure in this study was the systemic health, two of the three failed implants occurred in two hypertensive patients. A relation between systemic diseases with early implant failure was found by some researchers in patients with Gastric problems, Crohn's disease, diabetes type I, and women with radical hysterectomy.⁽⁷⁾ According to van Steenberghe *et al.* (2002) chemotherapy and radiotherapy of oral tissues were significantly related to implant failure.⁽¹⁷⁾

The results of the present study revealed that none of the local or implant-related factors significantly contribute in early failure. Regarding implant dimension, the three failed implants were 4.1mm in diameter, while two were 10 mm length and one was 6mm. Some studies concluded that early failure of short implants was more often than longer implants.^(18,31,36) Nevertheless and in agreement with our results, other researchers reported that implant length did not appear to significantly

influence the early success rate.^(21,37) Operators' learning curves and experience were reported to be a reason for the different reported outcomes with short or long implants between the studies (Olate *et al.* 2010). Pommer *et al.* in a recent meta-analysis on the impact of dental implant length on early failure rates concluded that in areas of reduced alveolar bone height the use of short dental implants may reduce the need for invasive bone augmentation procedures.⁽³⁷⁾

Inconsistent with our results, narrow diameter was found to be a significant risk factor for early implant failure.⁽²¹⁾ The use of implants with a larger diameter has been recommended for increasing the surface area of bone-implant contact, for cases of inadequate bone height or poor bone quality, and for the immediate replacement of fractured or non-integrated implants.⁽³⁸⁾ However, Poomer *et al.* (2011) reported that implant diameter increase can not compensate for length reduction.⁽³⁷⁾ In addition, implants with larger diameter did not show a higher success rate.^(18,36)

The results of the present study with regard to bone quality are consistent with Olate *et al.* (2010) and Baqaine *et al.* (2011) who found no significant effect between early loss of implants and the osseous quality, while contradictory with Olate *et al.* (2010) with regard to implant site, who found that early failure rate was more for maxillary than mandibular implants.^(21,36) Some studies have reported increased failure rates with implants placed in type IV bone,⁽³⁹⁾ which is more commonly found in maxilla and posterior segments of mandible, offers little cortex and minimal internal strength.⁽⁴⁰⁾ In the present study, two of the failed implants were placed in type II bone in the posterior mandible and one in type III bone in the posterior maxilla.

Conclusion

Early failure using Straumann AG dental implant system for fixed partial prosthesis was 0.8%, and this early failure was significantly associated with smoking, medical health, and periodontitis.

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