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Two-Year Success and Early Failure of Osseointegration of 3049 Dental Implants in Dubai Health Authority

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Abstract

Background: Replacing missing teeth using dental implants is a predictable treatment modality for completely and partially edentulous patients. Despite the high success and survival rates associated with dental implants, early implant failure (before loading) can occur and represents the majority of reported failure. The aim of the present study was to identify the factors associated with early failure of dental implants in patients of Dubai Health Authority (DHA), Dubai, United Arab Emirates.

Materials and Methods: In a retrospective study; 1608 records of patients who had received 3049 dental implants placed in DHA from January 2015 to December 2016 were analyzed together with the complementary documentation (panoramic and periapical radiographs) to identify factors associated with early failure of osseointegration. Collected data were analyzed using the Statistical Program for Social Sciences (SPSS) version 21 for windows. Descriptive statistics were performed using frequency count and percentages. Chi square tests were performed to determine the difference between the implant failure in both arches at significance level $p < 0.05$.

Results: Out of the 3049 dental implants placed, early failure occurred in 144 implants (4.72%). Males lost more implants (53.47%) in comparison to females (46.53%). Patients with age group of > 30 - 40 years showed higher failure rate with (28.47%). Narrow dental implants represented 74.31% of the failed implants (107 dental implants), while short dental implants showed 59.72% of the failed implants (86 dental implants). Among the associated systemic diseases, diabetes mellitus and hypertension were reported in (30%) of the failed cases. Early failure was more frequent when the implants were placed in the posterior mandible (45.14%) followed by posterior maxilla (36.11%). Implants placed with a conventional single stage surgical placement protocol showed the highest failure rate.

Conclusions: Within the limitations of this study, and although no statistical significant difference was reported; the descriptive data and the clinical observations showed that the use of narrow and short implants in the posterior mandible and maxilla, male gender, diabetes, hypertension, and the use of single stage implant placement protocol were found to be the factors associated with early implant failure.

Keywords: *Narrow and Short Implants; Single Stage; Diabetes; Hypertension*

Introduction

The reconstruction of missing teeth by titanium dental implants is currently the gold standard in dental rehabilitation [1,2]. Improvements in implant design, surface characteristics, and surgical protocols made implants a secure and highly predictable procedure with a mean survival rate of 94.6% and a mean success rate of 89.7% after more than 10 years [3]. However, despite the low number, failures occur, most of the time unexpectedly [4]. Implant loss is divided into early failure, before the occurrence of the osseointegration, and the late failure, after the implant receives occlusal load [5].

After the installation of endosseous implants, there are three possible responses that may occur in host tissues: (1) acute or chronic inflammatory process, causing early implant failure; (2) the formation of connective tissue surrounding implant, leading to osseointegration failure, and (3) living and functional bone tissue formation around the implants, resulting in osseointegration [6].

A number of factors had been suggested in the literature to affect implant survival, such as implant location, surgical technique, implant dimensions, and patient-related factors. However, there still appears to be a wide disparity in the literature relating to the impact of these risk factors on implant failure [7]. Accordingly, the aim of this study was to identify, retrospectively, factors associated with early failure of osseointegration of dental implants in patients of Dubai Health Authority (DHA), Dubai, United Arab Emirates.

Materials and Methods

In a retrospective study; 1608 records of patients who had received 3049 dental implants placed in Dubai Health Authority (DHA, Dubai, United Arab Emirates) from January 2015 to December 2016 were analyzed together with the complementary documentation (panoramic and periapical radiographs).

Due to the retrospective study design, the patients were not been exposed to any additional risk; therefore, an Ethical Committee approval was not sought for. All measures had been taken in order not to disclose any patient personal data. Study sample included all patients who had received dental implants in DHA during the study period with no exclusion criteria.

Patients received either ANKYLOS, XIVE, or ASTRA dental implants from DENTSPLY (DENTSPLY Implants, Mannheim, GERMANY). The possible associated factors with early implant failure were evaluated by analysis of dental records and complementary documentation (panoramic and periapical radiographs). These factors included; gender, age, and medical condition of the patients; size, position, and placement protocol of the dental implant.

For the analysis of implant diameter, the following classification was used: narrow when the diameter was less than 3.75 mm, regular when the diameter was 3.75 - 4.8 mm, and wide when the diameter was greater than 4.8 mm [8,9]. Regarding length, implants were classified as short when they were less than 10 mm, regular when 10 - 12 mm, and long when greater than 12 mm [10].

Collected data were analyzed using the Statistical Program for Social Sciences (SPSS) version 21 for windows. Descriptive statistics were performed using frequency count and percentages. Chi square tests were performed to determine the difference between the implant failure in both arches at significance level $p < 0.05$.

Results

The retrospective results represented the review of all consecutively placed implants in Dubai Health Authority (DHA) from January 2015 to December 2016. The study included 3049 dental implants placed in 1608 patients. Analysis of early failure due to lack of osseointegration was thoroughly investigated as follows:

The placed 3049 DENTSPLY implants happened to be distributed as follows: 2326 ANKYLOS implants (2213 successful, 113 failed with a success percentage of 95.14%), 475 XIVE implants (449 successful, 26 failed with a success percentage of 94.53%), 248 ASTRA implants (243 successful, 5 failed with a success percentage of 97.98%). Total number of implant failed among the 3 systems was 144 implants.

As for gender distribution, males lost more implants (77 patients) in comparison to females (67 patients). Mean age of study sample with failed implants was 47.7 for males and 45.3 for females (Table 1). No statistical significant difference was reported between the implant failure in both genders in relation to both arches with p-value = 0.155 (Table 2).

	Gender			
	Males (N1= 77)		Females (N2= 67)	
	Mean	SD	Mean	SD
Age	47.7	15.7	45.3	14.2

Table 1: *Mean age of study sample with failed implants.*

	Arch						X^2 (p)
	Maxillary		Mandibular		Total		
	No	%	No	%	No	%	
Male	37	55.2%	40	51.9%	77	53.5%	0.155 (0.695)
Female	30	44.8%	37	48.1%	67	46.5%	

Table 2: *Implant failure in both genders in relation to both arches*

*X2: chi square test; *: significant at p < 0.05*

Patients with failed implants were divided into 6 age groups; 18 - 30 (19 patients), > 30 - 40 (41 patients), > 40 - 50 (27 patients), > 50 - 60 (32 patients), > 60 - 70 (12 patients), > 70 (13 patients). Patients with age group of > 30 - 40 years showed higher failure rate with (28.47%) than the other age groups as shown in figure 1. No statistical significant difference was reported between the implant failure for different age groups in relation to both arches with p-value = 0.122 (Table 3).

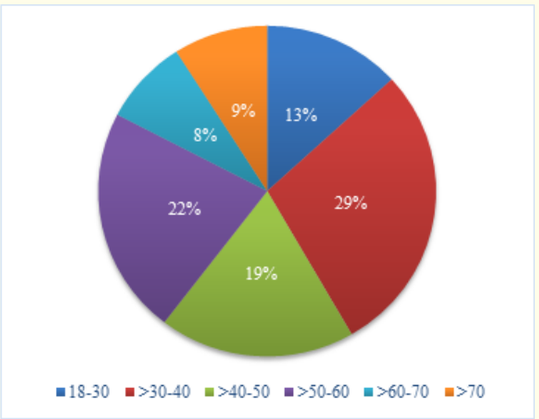

Figure 1: *Percentage of implant failure in relation to age.*

	Arch						X^2 (p)
	Maxillary		Mandibular		Total		
	No	%	No	%	No	%	
18 - 30 Y	14	20.9%	5	6.5%	19	13.2%	8.682 (0.122)
> 30 - 40 Y	18	26.9%	23	29.9%	41	28.5%	
> 40 - 50 Y	11	16.4%	16	20.8%	27	18.8%	
> 50 - 60 Y	11	16.4%	21	27.3%	32	22.2%	
> 60 - 70 Y	7	10.4%	5	6.5%	12	8.3%	
> 70 Y	6	9.0%	7	9.1%	13	9.0%	

Table 3: *Implant failure for different age groups in relation to both arches*
*X2: chi square test; *: significant at p < 0.05.*

Among the total number of implants placed regardless of the system and in correlation to the classification of implant size (diameter and length); narrow and short dental implants showed the highest failure rate (41.67%) followed by narrow and regular dental implants (29.17%), regular and short dental implants (15.97%), regular dental implants (6.94%), narrow and long dental implants (3.47%), wide and short dental implants (2.08%), and finally regular and long dental implants (0.69%). Narrow dental implants regardless of the length, represented 74.31% of the failed implants (107 dental implants); while short dental implants regardless of the diameter showed 59.72% of the failed implants (86 dental implants). Distribution of failed implants among each system in relation to implant size is shown in (Tables 4-6).

Classification	Implant Size	Number of Failed Implants	Percentage of Failed Implants
Narrow and short	ANKYLOS 3.5 X 6.6	1	0.88%
Narrow and short	ANKYLOS 3.5 X 8	12	10.62%
Narrow and short	ANKYLOS 3.5 X 9.5	44	38.94%
Narrow and regular	ANKYLOS 3.5 X 11	32	28.32%
Narrow and long	ANKYLOS 3.5 X 14	4	3.54%
Regular and short	ANKYLOS 4.5 X 8	4	3.54%
Regular and short	ANKYLOS 4.5 X 9.5	11	9.73%
Regular	ANKYLOS 4.5 X 11	4	3.54%
Wide and short	ANKYLOS 5.5 X 9.5	1	0.88%
	Total	113	100%

Table 4: *Distribution of failed ANKYLOS implants in relation to implant size in mm.*

Classification	Implant Size	Number of Failed Implants	Percentage of Failed Implants
Narrow and regular	XIVE 3 X 11	7	26.92%
Narrow and long	XIVE 3 X 13	1	3.85%
Narrow and short	XIVE 3.4 X 8	1	3.85%
Narrow and short	XIVE 3.4 X 9.5	2	7.69%
Narrow and regular	XIVE 3.4 X 11	3	11.54%
Regular and short	XIVE 3.8 X 9.5	5	19.23%
Regular and short	XIVE 4.5 X 8	1	3.85%
Regular and short	XIVE 4.5 X 9.5	2	7.69%
Regular	XIVE 4.5 X 11	1	3.85%
Regular and long	XIVE 4.5 X 13	1	3.85%
Wide and short	XIVE 5.5 X 9.5	2	7.69%
	Total	26	100%

Table 5: *Distribution of failed XIVE implants in relation to implant size in mm.*

Classification	Implant Size	Number of Failed Implants	Percentage of Failed Implants
Regular	ASTRA 4 X 11	5	100%

Table 6: *Distribution of failed ASTRA implants in relation to implant size in mm.*

Distribution of failed dental implants in relation to size regardless of the system is shown in figure 2. No statistical significant difference was reported between the implant failure in different diameters and lengths in relation to both arches with p-value=0.249 and 0.791 respectively (Tables 7-8).

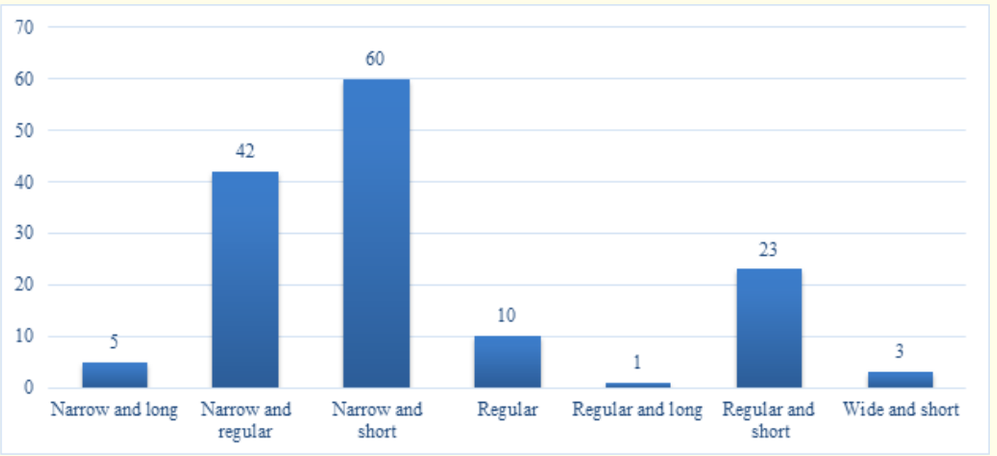

Figure 2: *Distribution of failed dental implants in relation to size.*

	Arch						X^2 (p)
	Maxillary		Mandibular		Total		
	No	%	No	No	%	No	
Narrow	50	74.6%	57	74.0%	107	74.3%	2.778 (0.249)
Regular	17	25.4%	17	22.1%	34	23.6%	
Wide	0	0.0%	3	3.9%	3	2.1%	

Table 7: *Implant failure in different diameters in relation to both arches.*

*X^2: chi square test; *: significant at $p < 0.05$*

	Arch						X^2 (p)
	Maxillary		Mandibular		Total		
	No	%	No	No	%	No	
Short	40	59.7%	46	59.7%	86	59.7%	0.470 (0.791)
Regular	25	37.3%	27	35.1%	52	36.1%	
Long	2	3.0%	4	5.2%	6	4.2%	

Table 8: *Implant failure in different lengths in relation to both arches.*
*X^2: chi square test; *: significant at $p < 0.05$*

Out of the 144 patients, 70 patients showed associated systemic diseases to early implant failure. Diabetes mellitus and hypertension were reported in (30%) of the failed cases. No statistical significant difference was reported between the implant failure in different systemic diseases in relation to both arches with p-value = 0.123 (Table 9).

	Arch						X^2 (p)
	Maxillary		Mandibular		Total		
	No	%	No	%	No	%	
Free	42	62.7%	32	41.6%	74	51.4%	0.8665 (0.123)
Diabetes	9	13.4%	15	19.5%	24	16.7%	
Hypertension	5	7.5%	15	19.5%	20	13.9%	
Thyroid	2	3.0%	4	5.2%	6	4.2%	
Dyslipidemia	3	4.5%	2	2.6%	5	3.5%	
Others	6	9.0%	9	11.7%	15	10.4%	

Table 9: *Implant failure in different systemic diseases in relation to both arches.*
*X^2: chi square test; *: significant at $p < 0.05$*

In relation to implant position, failure was more frequent when the implants were placed in the posterior mandible (45.14%) followed by posterior maxilla (36.11%), then anterior mandible (10.42%), and finally anterior maxilla (8.33%). Regardless of being placed anteriorly or posteriorly, maxillary or mandibular; left and right sides showed almost equal failure percentage with 75 (52%) and 69 (48%) dental implants respectively. Distribution of failed dental implants in relation to position into the oral cavity is shown in figure 3.

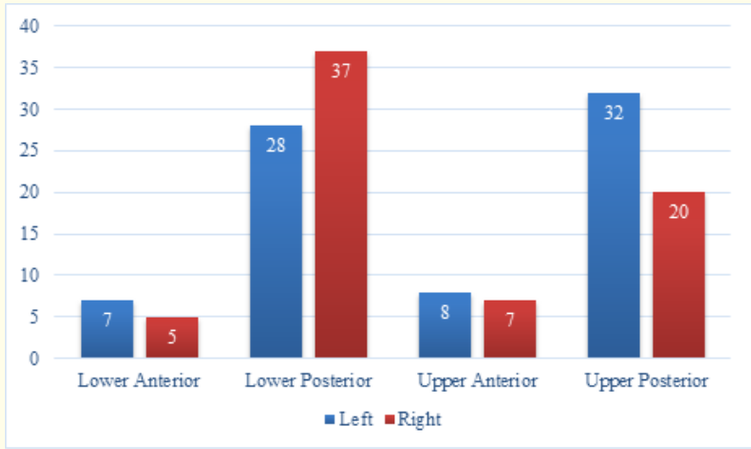

Figure 3: *Distribution of failed dental implants in relation to position into the oral cavity.*

As for the implant placement protocols, implants placed with a conventional single stage surgical placement protocol showed the highest failure rate (70 dental implants), followed by the implants replaced at the time of surgery due to lack of primary stability (44 dental implants), then conventional two stages protocol (24 dental implants), immediate single stage protocol (5 dental implants), and finally immediate two stages protocol (1 dental implant). No statistical significant difference was reported between the implant failure in different implant placement protocols in relation to both arches with p-value = 0.943 (Table 10).

	Arch						X^2 (p)
	Maxillary		Mandibular		Total		
	No	%	No	No	%	No	
Immediate	3	4.5%	3	3.9%	6	4.2%	0.388 (0.943)
Single stage	31	46.3%	39	50.6%	70	48.6%	
Two stages	11	16.4%	13	16.9%	24	16.7%	
Replaced in surgery	22	32.8%	22	28.6%	44	30.6%	

Table 10: *Implant failure in different implant placement protocols in relation to both arches.*
*X^2: chi square test; *: significant at $p < 0.05$*

Discussion

The present study was conducted to identify, retrospectively, factors associated with early failure of osseointegration of dental implants in patients of Dubai Health Authority (DHA), Dubai, United Arab Emirates. Factors included in the study were: gender, age, and medical condition of the patients; size, position, and placement protocol of the dental implant.

Sandblasting using 50 um aluminum oxide which used in this study was the same particles size as those used by many researchers [14,19]. Resin adheres to the enamel surface through the micro-mechanical engaging of resin to the hydroxyapatite crystals and rods of the etched enamel surface. The perfect bond strengths to the sandblasted base metal alloy due to the chemical communication of the resin with the oxide layer on the metal surface [20,21]. In another research done by Goswami., *et al.* [22] showed that sandblasting only produced less shear bond strength than clinically accepted.

Age showed no relation to early implant failure in the current study. This was in agreement with Pedro., et al. who verified that age is not a limiting factor for implant placement [11]. On the contrary, male gender was found to have more failure rate in comparison to female gender in the current study although no statistical significant difference was reported. This result is supporting similar earlier results by French., *et al.* and Becker., *et al.* who reported that male gender was found to trend toward higher failure rates [12,13].

The results of this study showed that 30% of early failure was reported in diabetic and hypertensive patients although no statistical significant difference was reported. According to Naujokat., *et al.* dental implants are safe and predictable procedures for dental rehabilitation in diabetics. Patients with poorly controlled diabetes seem to have delayed osseointegration following implantation. After 1 year, there is no difference between diabetic and healthy individuals, not even to the poorly controlled HbA1c. Therefore, avoiding immediate loading of the implants is recommended [14]. Moreover, Oates., *et al.* reported that patients with poorly controlled diabetes have lower stability at the first 2 to 6 weeks. In the following weeks, stability reaches the baseline again, but reaching baseline takes two times the duration it needs in the healthy treatment group [15,16]. This can explain the results of the current study that showed higher failure rates in diabetic patients who received implants placed using single stage protocol.

Wu., *et al.* reported that antihypertensive drugs in general are beneficial for bone formation and remodeling, and are associated with lower risk of bone fractures. The results of their study suggested that treatment with antihypertensive drugs may be associated with an increased survival rate of osseointegrated implants [17].

Contradictory to the results of the current study, which showed high early failure rates in hypertensive patients, it is highly recommended that further studies are to be conducted to evaluate and standardize treatment protocols for hypertensive patients who are going to receive dental implants.

In agreement with the results of the current study, more early implant failures for both mandibular and maxillary areas in posterior regions have been observed in previous reports [18-21]. This may be attributable to a combination of multiple preconditions often present in posterior sites, such as barely sufficient bone volume, and poor bone quality [22]. Moreover, the cortical layer of both jaws tends to become thinner and more porous posteriorly [23].

Although no statistical significant difference was reported; narrow and short dental implants placed showed the highest failure rate in this study (41.67%). Narrow dental implants regardless of the length, represented 74.31% of the total percentage of failed implants (107 dental implants). Olate., *et al.* showed similar results in their retrospective study which was conducted on 1649 implants (807 maxillary and 821 mandibular) placed in 650 patients. Regarding diameter, they observed that the largest loss was in narrow implants (5.1%), followed by regular (3.8%) and wide (2.7%) implants. While regarding length, the largest loss was observed in short implants (9.9%), followed by long (3.4%) and medium (3.0%) implants. They concluded that a significant relationship of early implant loss was observed with short implants [24].

In a retrospective analysis of 56 edentulous dental arches restored with 344 single-stage implants, Kinsel and Liss found that increased rates of failure were associated with reduced implant length, placement in the posterior region of the jaw, and surface treatment [25]. The current study showed similar results with high rates of early failure reported with implants placed with a conventional single stage surgical placement although no statistical significant difference was reported. Moreover, higher failure rates were reported in posterior segments and with short implants regardless of the diameter (59.72%). This can be explained due to the poor bone quality of the posterior segment, and the unmeasured forces caused by the relative immediate non-functional loading caused by the presence of the gingival former which needs to be counteracted by increasing the length of the placed dental implant.

Conclusions

Within the limitations of this study, and although no statistical significant difference was reported using Chi square test, the descriptive data and the clinical observations together with the analysis of the complementary documentation showed that; the use of narrow and short implants in the posterior mandible and maxilla, male gender, diabetes and hypertension, and the use of single stage implant placement protocol were found to be associated factors with early implant failure. The results of this study strongly recommend the following:

1. Care should be taken to ensure aseptic and atraumatic surgical placement of dental implants.
2. Diabetic and hypertensive patients should be properly assessed and controlled prior to implant placement.
3. Single stage surgical placement protocol should be avoided in the posterior jaw quadrants unless regular or long implant can be used with a good primary stability that can be measured accurately.
4. Improvement of bone quality in posterior mandible and maxilla is important to ensure the use of proper size of dental implants in correlation to the expected load.
5. Narrow and short dental implants should be avoided in areas of low bone quality as osseointegration may be compromised due to the decreased surface area of the implant in relation to a good in-situ quality bone.
6. More studies are needed to investigate the effect of male gender on early implant failure.

Competing Interests

Dr. Hamda Al Mesmar, Dr. Khalid Al Gergawi and Dr. Hazem Mourad declare that they have no competing interests.

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